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THE ECONOMIC DISTURBANCES SINCE 1873.

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I.

THE existence of a most curious and, in many respects, unprecedented disturbance and depression of trade, commerce, and industry, which, first manifesting itself in a marked degree in 1873, has prevailed with fluctuations of intensity up to the present date of writing (1887), is an economic and social phenomenon that has been everywhere recognized. Its most noteworthy peculiarity has been its universality; affecting nations that have been involved in war as well as those which have maintained peace; those which have a stable currency, based on gold, and those which have an unstable currency, based on promises which have not been kept; those which live under a system of free exchange of commodities, and those whose exchanges are more or less restricted. It has been grievous in old communities like England and Germany, and equally so in Australia, South Africa, and California, which represent the new; it has been a calamity exceeding heavy to be borne, alike by the inhabitants of sterile Newfoundland and Labrador, and of the sunny, fruitful sugar-islands of the West Indies; and it has not enriched those at the centers of the world's exchanges, whose gains are ordinarily the greatest when business is most fluctuating and uncertain.*

* The poverty in Australia, in 1885, was reported to be more extreme than at any former period in the history of the colonies; multitudes at Adelaide, South Australia, surrounding the Government House and clamoring for food—the causes of distress assigned being failure of the harvest, drought, and general commercial depression.

"The close of the year 1884 brought with it little, if any, improvement, in the material condition of South Africa. Commercial disasters may not have been so frequent as during the previous year, but this may be explained by the fact that trade has reached so low a level that very little room existed for further failures. No new enterprises have

One of the leading economists and financiers of France, M. Leroy Beaulieu, claims that the suffering has been greatest in his country, humiliated in war, shorn of her territory, and paying the maximum of taxation; but not a few stand ready to contest that claim in behalf of the United States, rejoicing in the maintenance of her national strength and dominion, and richer than ever in national resources.

Commenting upon the phenomena of the industrial depression subsequent to the early months of 1882, the Director of the United States National Bureau of Labor, in his report for 1886, considers the nations involved, in respect to their relations to each other and to severity of experience, to stand in the following order: Great Britain, the United States, Germany, France, Belgium. The investigations of the director also indicated a conclusion (of the greatest importance in the consideration of causes); namely, that the maximum of economic disturbance has been experienced in those countries in which the employment of machinery, the efficiency of labor, the cost and the standard of living, and the extent of popular education are the greatest; and the minimum in countries, like Austria, Italy, China, Mexico, South America, etc., where the opposite conditions prevail. These conclusions, which are concurred in by nearly all other investigators, apply, however, more especially to the years prior to 1883, as since then "depression" has manifested itself with marked intensity in such countries as Russia, Japan, Zanzibar, Uruguay, and Roumania.

The business of retail distribution generally—owing, probably, to the extreme cheapness of commodities—does not, moreover, appear to have been less profitable than usual during the so-called period of depression; in contradistinction to the business of production, which has been generally unprofitable.

It is also universally admitted that the years immediately precedent to 1873—i. e., from 1869 to 1872—constituted a period of most extraordinary and almost universal inflation of prices, credits, and business; which, in turn, has been attributed to a variety or sequence of influences; such as excessive speculation; excessive and injudicious construction of railroads in the United States, Central Europe, and Russia (1867–'73); the opening of the Suez Canal (1869); the Franco-German War (1870–'71); and the payment of the enormous war indemnity of fifty-five hundred million francs (eleven hundred million dollars) which Germany exacted from France (1871–'73). The con-

been set on foot, and the suspension of many of the public works has tended to further reduce the commercial prosperity of the country. Consumption has been upon the lowest possible scale, retrenchment universal, and want of employment, and even of food, among the laboring-classes, a grave public difficulty."—*United States Consul* SILER, *Report to State Department, 1885.*

January, 1885. "The price of mackerel in 1884 (Boston) was lower than at any time since 1849; and, in the case of codfish, the lowest since 1838.

"The price obtainable for sugar at Barbadoes entails a loss to the producer in excess of one pound per ton."—*Barbadoes Agricultural Reporter, February, 1887.*

temporary comments of two English journals, of recognized authority, on the course of events in 1872, constitute also an important contribution to our information on this subject. Under date of March, 1873, the London "Economist," in its review of the commercial history of the preceding year, says :

> Of all events of the year (1872) the profound economic changes generated by the rise of prices and wages in this country, in Central and Western Europe, and in the United States, have been the most full of moment.

And the "London Engineer," under date of February, 1873, thus further comments on the situation :

> The progress of events during 1872 will not soon be forgotten by engineers. The position assumed by the working-classes, and the unprecedented demand for iron and machinery, combined to raise the cost of all the principal materials of construction to a point absolutely without parallel, if we bear in mind that the advance of prices was not localized, but universal, and that the duration of the rise was not limited to a few months or weeks, but, having extended already over a period of some months, shows little sign at this moment of any sensible abatement. *In 1872 scarcely a single step in advance was made in the science or practice of mechanical engineering. No one had time to invent, or improve, or try new things.* The workingman is setting spurs to his employers with no gentle touch, and already we find that every master with capital at stake is considering how best he can dispense with the men who give him so much trouble. Of course, the general answer always assumes the same shape—use a tool whenever it is possible instead of a man.

The period of economic disturbance which commenced in 1873 appears to have first manifested itself almost simultaneously in Germany and the United States in the latter half of that year. In the former country the great and successful results of the war with France had stimulated every department of thought and action among its people into intense activity. The war indemnity, which had been exacted of France, had been used in part to pay off the debt obligations of the Government, and ready capital became so abundant that banking institutions of note almost begged for the opportunity to place loans, at rates as low as one per cent, with manufacturers, for the purpose of enlarging their establishments. As a legitimate result, the whole country projected and engaged in all manner of new industrial and financial undertakings. In Prussia alone six hundred and eighty-seven new joint-stock companies were founded during the year 1872 and the first six months of 1873, with an aggregate capital of $481,045,000. Such a state of things, as is now obvious, was most unnatural, and could not continue ; and the reaction and disaster came with great suddenness, as has been already stated, in the fall of 1873, but without anticipation on the part of the multitude. Great fortunes rapidly melted away, industry became paralyzed, and the whole of Germany passed at once from a condition of apparently great prosperity to a depth of

financial, industrial, and commercial depression that had never been equaled.

In the United States the phenomena antecedent to the crisis were enumerated at the time to be, "a rise of prices, great prosperity, large profits, high wages and strikes for higher; large importations, a railway mania, expanded credit, over-trading, over-building, and high living." The crisis began on the 17th of September, 1873, by the failure of a comparatively unimportant railway company—the New York and Oswego Midland. On the 18th, the banking-house of Jay Cooke & Co. failed. On the 19th, nineteen other banking-houses failed. Then followed a succession of bankruptcies, until in four years the mercantile failures had aggregated $775,865,000; and on January 1, 1875, the amount of American railway bonds in default amounted to $789,367,655.

The period of economic disturbance which thus began in Germany and the United States soon extended to France and Belgium; and thereafter, but with varying degrees of severity, to Great Britain (i. e., in the latter months of the succeeding year), to the other states of Europe, and ultimately to the commercial portions of almost every country. The testimony before the British Parliamentary Commission (1885–'86), however, shows that the depression in Great Britain was not at once universal; but that, on the contrary, production, employment, and profits, at such great manufacturing centers as Birmingham and Huddersfield, were above the average until 1875.

By many writers on this subject, the depression and disturbance of industry, which commenced in 1873, are regarded as having terminated in 1878–'79; but all are agreed that they recommenced, with somewhat modified conditions, and even with increased severity, in 1882–'83. A full consideration of the larger evidence which is now (1887) available would, however, seem to lead to the conclusion that there really was no termination of the abnormal course of events, the marked and definite commencement of which is assigned to 1873, but that what has been regarded as a "termination" was only an "interruption," occasioned by extraordinary causes, varying locally, and by no means universal. Thus, a failure during the years 1879, 1880, and 1881, of the cereal crops of Europe and most other countries of the world, with the exception of the United States—a failure for which, in respect to duration and extent, there had been no parallel in four centuries—occasioned a remarkable demand on the latter country for all the food-products it could supply at extraordinary prices—the exportations of wheat rising from 40,000,000 bushels in 1877 to 122,000,000 in 1879, 153,000,000 in 1880, and 150,000,000 in 1881; while the corresponding values of the amount exported rose from $47,000,000 in 1877 to $130,000,000 in 1879, $190,000,000 in 1880, and $167,000,000 in 1881. There was also a corresponding increase in the quantity and value of the American exports of other cereals, and also of

most meat products and provisions.* Such a demand at extraordinary prices for crops, beyond the average in quantity and quality, brought temporary prosperity to American producers, and induced great industrial and commercial activity throughout the United States; and although the crops of other countries were notably far below the average, yet the great advance in prices undoubtedly went far to alleviate the distress of the foreign agriculturist, even if it did not in some cases actually better his condition, and increase his purchasing power of other than food-products. The extent to which the American producer availed himself of his increased purchasing power during the years under consideration is indicated by the increase which occurred in the importation of foreign merchandise on the part of the United States, namely, from $437,051,000 in 1878 to $667,954,000 in 1880, and $722,639,000 in 1882. Such an increase represented payment in part for American exports ($110,575,000 in gold and silver being imported in addition in 1881), and a corresponding demand for the products of foreign industries—the special effect on British industry being characterized by a statement from one of the witnesses before the Royal Commission (a representative of one of the districts of Liverpool), that "the depression continued until 1880, when there occurred an American boom, which temporarily lifted prices and induced activity." The testimony of other witnesses was, however, to the effect that in many branches of British industry there was no improvement of condition either in 1878, 1880, or in any subsequent year; the Commission itself reporting (in December, 1886) that there was a general agreement among those whom it consulted, that the depression under consideration, "so far as Great Britain was concerned, dates from about the year 1875, and, with the exception of a short period enjoyed by certain branches of trade in the years 1880 to 1883, it has proceeded with tolerable uniformity, and has affected the trade and industry of the country generally, especially those branches connected with agriculture." The Commission further reports that the information received by them leads to the conclusion that "in Belgium, France, Russia, Scandinavia, Spain, and the United States," the depression has been "almost identical in its leading features with that existing in the United Kingdom."

In Germany and Belgium the reaction experienced in 1879, it is admitted, did not extend beyond 1882.

In France the condition of agricultural and other laborers continued so deplorable that the French Chamber of Deputies appointed a special commission of inquiry in 1884 with a view to devising measures for re-

* No. 1 spring wheat, which commanded $1.05 per bushel in the New York market on the 1st January, 1878, was quoted at $1.60 at a corresponding date in 1879; and at $1.39 in 1881. The corresponding advance in corn was from 45 cents per bushel in 1878 to 63 cents in 1879, and 70 cents in 1881; while the advance in mess-pork was from $7.05 per barrel in 1878 to $12.62½ in 1879, and $17 in 1881.

lief; while in Great Britain the condition of trade and industry has uninterruptedly been regarded, since 1882–'83, with great anxiety. There is a very general agreement of opinion in England and on the Continent of Europe that the years 1879, 1885, and 1886 were the worst that have been experienced in the period commencing with 1873. In England, France, and Germany, the increase or decrease in exports is popularly regarded as an indication of the condition of business, and assuming 100 to represent the exports for 1883, the decline in the value of the exports of these several countries since that year may be represented as follows: England, 1883, 100; 1884, 92·2; 1885, 88·5, a falling off in two years of 11·2 per cent. The record of France is better—1883, 100; 1884, 93·1; 1885, 92·3, a falling off of 7·7 per cent; while Germany falls behind both countries: 1882, 100; 1883, 98; 1884, 89; 1885, 87·5, a falling off of 12·5 per cent.

One point of interest which is here specially worthy of note from its bearing on the discussion of causes, is that the recurrence of the period of depression in 1882, after the favorable reaction which occurred to a greater or less extent in 1879, was quiet and gradual, as if matters were naturally again assuming a normal condition, and was not preceded or accompanied by any marked financial or commercial disturbances. On the contrary, the money markets of the world remained "easy," and were characterized, as they have ever since been, by a plethora of capital seeking investment and a low rate of interest; so that the economic disturbance since 1882 has been mainly in the nature of a depression of industry, with a renewed and remarkable decline of prices; with absolutely no decline, but rather an increase in the volume of trade, and certainly no falling off in production, as compared with the figures of 1880 and 1881, which years in the United States, and to some extent in other countries, were regarded as prosperous.

The following presentation, chronologically arranged, of brief extracts from various publications since 1872–'73, will further assist to a recollection and comprehension of the course of events since that period, and also exhibit the opinions which have been expressed at different times, respecting the "influence," "causes," and duration of the so-called "depression of trade and industry," by those who, by position or investigation, have assumed to speak with more or less of authority on the subject. And, with this intent, attention is first asked to the following retrospect of the curious experience of the iron and steel industry of the United States, as exhibited by quotations from the reports of the American Iron and Steel Association from 1873 to 1887:

1873. The year 1872 opened with an increased demand for iron in nearly all civilized countries. Prices advanced rapidly in all markets. The supply was unequal to the demand, although production was everywhere stimulated. In the United States forty new blast-furnaces were erected, and the erection of others

was undertaken. The rapidity with which iron rose in price in the United States is shown by the circumstance that No. 1 pig-iron, which sold for $30.50 per ton at Philadelphia, in January, 1871, sold for $37.50 in January, 1872, and $58 in September of the same year.—*Report of the American Iron and Steel Association, November, 1873.*

1874. The reaction (in the world's demand for iron) in 1874 has been as general and decided as the advance in 1872 was unexpected and bewildering. It has been felt most severely in the United States; but in the United Kingdom, and in France and Germany, the iron industry has been so much depressed, all through the year, that many iron-works have been closed, and many others have been employed but a part of the time. The testimony of statistics, and of all calm observers, shows that prostration is greater at the close of 1874 than it was at the close of 1873, and that the general distress is greater. At least a million of skilled and unskilled working-men and working-women in this country are out of employment to-day, because there is no work for them to do.—*Report, December 31, 1874.*

1877. Since 1873 each year has shown a decrease in the production of pig-iron in the United States, as compared with the preceding year, the percentage of decrease being as follows: 1874, six per cent; 1875, fifteen per cent; 1876, eight per cent. This is a very great shrinkage, and indicates, with concurrent low prices, a very great depression in the pig-iron industry of the country. If the rate of decrease which marked the period from 1873 to 1876 were to be continued, the production of pig-iron in the United States would entirely cease in 1884, less than eight years from the present time, and our furnace-stacks would only be useful as observatories for the study of astronomy. But our pig-iron industry is not destined to come to such an untimely end, for we see that the heavy percentage of decrease which had characterized the year 1875 was not continued in 1876. It seems plain that the production of pig-iron commenced last year to rally from the effects of the panic of 1873.—*Report, June, 1877.*

1878. The year 1877 witnessed an increased demand for some of our iron and steel products, as compared with 1876; neutralized, however, so far as producers were concerned, by a very marked decrease in prices. Nor did low prices form the only unfavorable feature of the iron trade of 1877. More than one half of the furnaces, and many of the rolling-mills, were idle the whole year. Prices were so low as to warrant the opinion that they could be no lower. Hence, mainly, the increased consumption of iron in that year.—*Report, July, 1878.*

1879. In nearly all the branches of the domestic iron and steel industries there has been an increased production in 1878 over 1877; but this increase in production has been accompanied by a decrease in prices. At no time in the history of the country have prices for iron and steel been as low as they were in 1878, excepting in colonial days, when the price of pig-iron was lower.—*Report, May 6, 1879.*

1880. Near the close of 1878 it became evident that the business depression which had succeeded the panic of 1873 was slowly disappearing, and that a general revival of prosperity was at hand. The country had been favored with good crops, and short harvests abroad has caused a demand for agricultural surplus. In the spring months of 1879 the managers of the leading railroads of the country, being assured of a continued increase of their business through the unfavorable outlook for the European harvests, simultaneously began to give out orders for materials containing iron and steel. In the closing months of 1879 excitement and speculation took the place of the gloom and discouragement with

which the American iron-trade had been so familiar scarce one year before, and the business of buying and selling iron became close neighbor to that of gambling in stocks.—*Report, May, 1880.*

No. 1 pig-iron, which sold for $53 per ton at Philadelphia in September, 1872, sold for $24 in 1874, $21.25 in 1876, $16.50 in 1878, $41 in February, 1880; $25 in May, 1880; $26 in 1882, $18.50 in 1884, $17.75 in 1885, and $18.50 in 1886.

1882. The year 1881 was the most prosperous year American iron and steel manufacturers have ever known.—*Report, June, 1882.*

1883. The extraordinary activity in our iron and steel industries, which commenced in 1879, culminated early in 1882. The reaction was not sudden, but was so gradual and tranquil that for some time it excited no apprehension. In November and December the market was greatly depressed. At the beginning of December, 1881, the average price of steel rails at the (American) mills was $60 per ton, but in December, 1882, the average price was only $39.* In all the fluctuations of iron and steel that have taken place in this country, we know of none so sweeping as this decline in the price of steel rails, if we except in 1879 and 1880, and many of these were entirely speculative.—*Report, May, 1883.*

The cause of this serious reaction was attributed, in the same report, in great measure to the circumstance that "we had increased our capacity for the production of most forms of iron and steel much faster than the consumptive wants of the country had increased."

1884. Since the publication of the last annual report, in May, 1883, the unsatisfactory condition of the American iron-trade, as it then existed, has not improved. It has steadily grown worse.—*Report, May, 1884.*

1887. The year 1886 was one of the most active years the American iron-trade has ever experienced. The improvement in demand which had commenced in the latter part of 1885 was well maintained throughout the whole of 1886. The production of the year in all the leading branches of the trade was much the largest in our history. The remote causes of the revival in the prosperity of the American iron-trade which began in the last half of 1885, and still continues, may be difficult to discover; but one influential immediate cause is directly traceable to the meeting of the Bessemer steel-rail manufacturers in August, 1885, at which meeting a restriction of production for one year to avoid the evils of over-production and ruinous prices was agreed upon. This action was almost immediately followed by beneficial results to the iron-trade of the whole country, and to many other branches of domestic industry. We do not forget that the revival in railroad-building which commenced in the late months of 1885, and has continued to the present time (1887), has been the influence which most stimulated the demand for iron and steel; but it was the action of the Bessemer steel-rail manufacturers which put a check to the demoralization of prices which prevailed prior to their meeting, and stimulated the managers of existing railroads to hasten their arrangements for contemplated repairs and equipments. An incident of our industrial history for 1886 was the large number of strikes among workingmen. More American workingmen were volun-

* The average price of Bessemer steel rails, which commanded $39 per ton at American mills in December, 1882, declined to $25 in 1885.

tarily out of employment in that year than in any previous year.—*Report for April, 1887.*

The following extracts from published statements and opinions are more general in their nature, but not less instructive:

1876. Our country is now passing through a period of unusual depression, both in its industries and its business. The present depressed condition of business and of financial affairs exists over all countries having a high civilization.—*Facts and Observations addressed to the Committee on Finance of the Mutual Life-Insurance Company of New York, July, 1876. Printed for the Private Convenience of the Trustees.*

1876. The inquiry has been sufficiently broad to enable them (the committee), to point out with a considerable degree of accuracy the causes which have immediately operated to produce the present depression in the commerce of the country, and in some branches of its manufacturing and mining industries. These causes are quite beyond legislative control in this country.—*Report of Select Committee of the House of Commons, Dominion of Canada, 1876.*

1877. Hard times! For four years this sober pass-word has gained in gravity of import. For a time it was panic; but suppositions of speedy recovery have given place to a conviction of underlying facts that these hard times are more than a panic; that the existing depression of trade and dearth of employment are not, in popular apprehension, exaggerated, but are the serious results of causes more permanent in their nature than is generally considered.—*Hard Times, by Franklin W. Smith, Boston, 1877, James R. Osgood & Co.*

CONGRESS OF THE UNITED STATES, HOUSE OF REPRESENTATIVES, *June* 17, 1878.

1878. Mr. Thompson submitted the following resolution, which was agreed to:

Whereas, labor and the productive interests of the country are greatly depressed, and suffering severely from causes not yet fully understood, etc.: Therefore,

Resolved, That a committee of seven members of this House be appointed, whose duty it shall be to inquire into and ascertain the causes of general business depression, etc., and report at the next session.

1878. Commercial depression is the universal cry—a commercial depression probably unprecedented in duration in the annals of trade, except under the disturbing action of prolonged war. . . . Ample evidence abounds on all sides to show its extent and severity in England. Have other countries bowed their heads in suffering under the commercial depression? Let America be the first to speak. In 1873 she experienced a shock of the most formidable kind. She has not recovered from the shock at this very hour. Let us visit Germany—Germany the conqueror in a great war, and the exactor of an unheard-of indemnity. What do we find in that country? Worse commercial weather at this hour than in any other. Nowhere are louder complaints uttered of the stagnation of trade. Austria and Hungary repeat the cry, but in a somewhat lower voice. And so we come round to France, the people whose well-being has been so visited with the most violent assaults. Her losses and sufferings have surpassed those endured by any other nation. Yet the deep, heavy pressure of her commercial paralysis has weighed upon her the least oppressive of all. Such a depression, spread over so many countries, inflicting such continuous distress, and lasting for so long a period of time, the history of trade has probably never before exhibited.—BONAMY PRICE, *Contemporary Review, 1878.*

1879. The prevailing depression in business from which this country has suffered for six years, and from which nearly every country in Europe is suffering still, has probably furnished support to a greater number of conflicting economical theories than any other occurrence of ancient or modern times. . . . The result, we need hardly say, has not been to raise the reputation of political economy as a science. In fact, it has never seemed so little of a science as during the past five years, owing to the extraordinary array of proof and illustration which the holders of the most widely divergent views have been able to produce.—*The Nation* (*New York*), *May, 1879.*

1879. We have just passed through a period of depression, of which, though it came in perfect agreement with all past experiences, was complicated by such an exceptional conglomeration of untoward circumstances, and protracted to such a weary length, that men seemed to lose faith in the revival which was almost certain to come sooner or later, and began to ask whether the commercial supremacy of this country was not permanently undermined. And now, with the new decade, the revival is really here.—*The Recent Depression of Trade, being the Oxford Cobden Prize Essay for 1879, by Walter E. Smith, London, Trübner & Co., 1880.*

1881. The industrial depression is generally thought to have commenced in the closing months of 1874, and it increased in intensity throughout 1876 and 1877.—*Professor* HENRY FAWCETT, "*Free Trade and Protection*," *London, 1881.*

1885. The present depression of trade is remarkable, not so much for its intensity or for its extent—in both of which respects it has been equaled or surpassed on previous occasions—but for its persistence during the long period of eleven years. The industrial depression is generally thought to have commenced in the closing months of 1874; and, during every succeeding year, it has continued to be felt with more or less severity, and its remarkable persistence has been commented on by politicians and public writers. Usually, a period of depression is quickly followed by one of comparative prosperity. Such a reaction has been again and again predicted in this case, but, up to the present time, there are no satisfactory indications that the evil days are passing away. It is evident, therefore, that we are suffering in an altogether exceptional manner; that the disease of the social organism is due to causes which have not been in action on former occasions, and that the remedial agencies which have been effective on former occasions have now failed us.—*Bad Times, an Essay on the Present Depression of Trade, by Alfred Russel Wallace, London, October, 1885.*

The following are notable extracts from the testimony presented to the Royal (British) Commission, appointed August, 1885, to inquire into the depression of trade and industry, and embodied in their reports submitted to Parliament in 1885–'86:

1885. At the present time, a general depression of trade and industry is stated to exist throughout Italy. While, however, depression is general, it does not act uniformly on all industries.—*Testimony of Ellis Colnaghi, Her Majesty's Consul-General at Florence, October 8, 1885.*

The depression began full ten years ago, and still continues.—*Testimony of the Linen Merchants' Association of Belfast, Ireland, November, 1885.*

The origin of the depression from which we suffer, and which is at the lowest point yet reached, seems to be a reaction from the coal-famine period of 1872–'74, and which was perhaps due to the inflation consequent on the Franco-

German War in 1870. The progress of depression has been irregular, but with a persistent downward tendency since 1874. The present tendency is still downward.—*Testimony of the North of England Iron Manufacturers' Association, September, 1885.*

The depression has been increasing in intensity during the last four years. It was probably never greater than at present at this season of the year.—*Testimony of the British Paper-Makers' Association, September, 1885.*

Trade began to be depressed in 1876, and has continued so till the year 1883, with intermittent spurts of improvement But from the end of 1883 the depression has become increasingly acute.—*Testimony of North Staffordshire Chamber of Commerce, October 21, 1885.*

As a proof of the deplorable state this trade [woolen-yarn spinning, Huddersfield, England] has been in for the last ten or fifteen years, we most respectfully beg to inform you, we hold the list of fifty firms of spinners who have been ruined and brought into the bankruptcy court during that period. Another proof of the very serious state of trade here is to be found in the depreciated value of carding and spinning machinery. Good machines, and for all practical purposes equal to new, if brought into the market will only realize some thirty or forty per cent of their cost price. Mill property is also in a similar position.—*Report of the Huddersfield (England) Chamber of Commerce, October, 1885.*

1886. Out of the total number of establishments, such as factories, mines, etc., existing in the country [the United States], about eight per cent were absolutely idle during the year ending July 1, 1885, and perhaps five per cent more were idle a part of such time; or, for a just estimate, seven and a half per cent of the whole number of such establishments were idle, or equivalent to idle, during the year named. . . . Making allowance for the persons engaged in other occupations, 998,839 constituted "the best estimate" of the possibly unemployed in the United States during the year ending July 1, 1885 (many of the unemployed, those who under prosperous times would be fully employed, and who during the time mentioned were seeking employment), that it has been possible for the Bureau to make. . . . A million people out of employment, crippling all dependent upon them, means a loss to the consumptive power of the country of at least $1,000,000 per day, or a crippling of the trade of the country of over $300,000,000 per annum.—*Report on Industrial Depression, United States Bureau of Labor, 1886.*

1886. It may be remembered that about twelve months ago there were evidences of an improved feeling in the English iron-trade. This was caused by the news of improvement in America; but this better feeling soon passed away, and was succeeded by even a deeper depression and lower prices. . . . On examining the Board of Trade returns, it is disappointing to find that any improvement in our exports is confined almost exclusively to the United States, and that many of our principal customers have been taking less than formerly. This, however, may be explained by the depression which has hung over other countries in common with our own.—*London Statist, November, 1886.*

1886. The present crisis has a much more general character than any of the crises which have preceded it; because it is a part of an abrupt transformation in the production and circulation of the whole world. For the same reason, it is destined to last longer.—M. Leroy Beaulieu, *Revue des Deux Mondes, 1886.*

1887. It is pretty well known that the late revival in the English iron-trade was largely, if not exclusively, due to an increased demand from the United

States, which set in during the latter part of 1886, there being no increase in our exports to other countries.—*London Economist, April, 1887.*

The *octroi* receipts of the city of Paris from taxes levied at the gates on articles of food, coal, and building materials, which are the barometer of trade in the metropolis, contrast unfavorably with last year.—*Ibid.*

It is of interest to note how few, relatively, of the staples, raw materials or finished products, have left the year 1886 with any special gain in price as compared with one year or with two years ago, and it is even mere striking to enumerate the list of those which show actually no gain at all, or a loss in price.—*Bradstreet's Journal, January, 1887.*

Wheat, oats, sugar, butter, tobacco, and petroleum were lower in price at the close of 1886 than at the close of 1885. Corn, oats, pork, lard, and cotton were lower at the close of 1886 than at the begining of 1885.—*Ibid.*

The tables of the London "Economist" also represent but a very slight gain in the index number representing the combined prices of twenty-two leading commodities on the English market for the quarter ending March 31, 1887, as compared with the corresponding quarter from the three preceding years, "the gains being mostly articles not of first-class importance."

It is almost unnecessary to say that a subject of such transcendent importance, and affecting so intimately the material interests alike of nations and individuals, has naturally attracted a great and continually increasing attention throughout the whole civilized world, entailing at least one notable result, namely, that of a large and varied contribution to existing economic literature. Thus, State commissions for inquiring into the phenomena under consideration have been instituted by Great Britain, the United States, France, Italy, and the Dominion of Canada, all of which have taken evidence and reported more or less voluminously; the report of the Royal British Commission (1885–'86), comprising five folio volumes of an aggregate of about 1,800 pages; and that of Italy (1886), fifteen volumes with appendices; while the books, pamphlets, magazine articles, and reviews on the same subject, including investigations and discussions on collateral matters regarded as elements or results of the economic problem (such as the wide-spread ferment and discontent of labor, and the changes in the monetary functions of gold and silver), which have emanated from individuals or commissions, have been sufficiently numerous to constitute, if collected, a not inconsiderable library.

In all these investigations and discussions, the chief objective has been the recognition or determination of causes; and most naturally and legitimately, inasmuch as it is clear that only through such recognitions and determinations can the atmosphere of mystery which to a certain extent envelops the phenomena under consideration be dispelled, and the way prepared for an intelligent discussion of remedies. And on this point the opinions or conclusions expressed have been widely and most curiously different. Nearly all investigators are agreed that the wide-spread and long-continued "depression of business" is referable not to one but a variety of causes, which

have been more or less influential; and among such causes the following are generally regarded as having been especially potential: "Overproduction"; "the scarcity and appreciation of gold," or "the depreciation of silver, through its demonetization"; "restrictions of the free course of commerce" through protective tariffs on the one hand, and excessive and unnatural competition occasioned by excessive foreign imports contingent on the absence of "fair" trade or protection on the other; heavy national losses, occasioned by destructive wars, especially the Franco-Prussian War; the continuation of excessive war expenditures; the failure of crops; the unproductiveness of foreign loans or investments; excessive speculation and reaction from great inflations; strikes and interruption of production consequent on trades-unions and other organizations of labor; the concentration of capital in few hands, and a consequent antagonizing influence to the equitable diffusion of wealth; "excessive expenditures for alcoholic beverages," and a "general improvidence of the working-classes." In the investigations undertaken by committees of Congress in the United States, the causes assigned by the various witnesses who testified before them were comprised under no less than one hundred and eighty heads; and an almost equal diversity of opinion was manifested by the witnesses who appeared before the Royal (British) Commission.* The special causes to which a majority of the Commission itself attached any great degree of importance, stated in the order presented by them, are as follows: 1. Changes in the distribution of wealth—i. e., in Great Britain; 2. Natural tendency to diminution in the rate of profit consequent on the progressive accumulation of capital; 3. Overproduction; 4. Impairment of agricultural industry consequent on bad seasons, and the competition of the products of other soils which can be cultivated under more favorable conditions; 5. Foreign tariffs and bounties and the restrictive commercial policies of foreign countries; 6. The working of the British Limited Liability Act. In addition to these special causes, others of a general character were mentioned; such as "the more limited possibilities of new sources of demand throughout the world, and the larger amount of capital seeking employment"; "the serious fall in prices"; "the appreciation of the standard of value" so far as connected with the fall of prices and foreign competition. A respectable minority of the commission also included, in the list of principal causes, the effect of British legislation, regulating the hours and conditions of labor on the cost of production

* The Birmingham Chamber of Commerce attributed it in great part to German and Belgian competition, to foreign import duties on home-manufactured goods exported abroad, and exorbitant railway rates; the Hartlepool Chamber to foreign competition; Manchester, the same; Leeds, "to foreign tariffs"; Liverpool, to a loss in a once large re-export trade in cotton; Wolverhampton, to changes in the hours of labor resulting from the operation of the Factory, Workshop, and Education Acts, and the action of the various trades-unions.

as compared with other countries; and the discriminations given by British railways to foreign producers in the conveyance of goods.

It would seem as if one could not acquaint himself to any considerable extent with the great body of literature on this subject of the recent depression of trade, without becoming impressed with the tendency of many writers and investigators of repute, and of most of the persons who have given testimony before the commissions of different countries, to greatly magnify the influence of purely local causes. "The real and deep-seated cause of all our distress," says the "Oxford Prize Essay" for 1879, "is this: the whole world has been consuming more than it has produced, and is consequently in a state of impoverishment, and can not buy our wares."

Nearly all British writers dwell upon the immense losses to British farming capital, contingent upon deficient crops since 1875, and the decline in the value and use of arable land in the United Kingdom, and concurrent decline in the price of agricultural produce, due to foreign competitive supplies, as prime factors in accounting for trade depression; while, throughout much of the testimony given before the British Commission by British manufacturers and merchants, the injurious influence of hostile foreign tariffs on the exports of British manufactures, and the competition of foreign manufactures in the British home market, are continually referred to as having been especially productive of industrial disturbance. In France, the principal assigned causes are, excessive speculation prior to 1873, followed by bad crops; the great falling off in the production of wine through the destruction of vineyards by the phylloxera; a serious depression of the silk-trade industry; the disappearance of sardines and other fish from the coast of Brittany; excessive taxation; excessive increase in manufactured products; and restricted markets due to the competition of foreign nations paying less wages. In Italy a succession of bad crops, a disease among the silk-worms, and a stagnation of the silk industry, are prominently cited; while in Denmark, bad harvests, a disturbed state of internal politics, an alteration in the metallism of the country in 1873, and general over-production of manufactured products, are popularly assigned as sufficient causes.

Excessive taxation upon trade and industry, as a leading cause of trade depression, has also found strong advocacy, and the evidence brought forward is certainly impressive. The present annual burden of taxation in Europe for military purposes at the present time is estimated at about £170,000,000 ($850,000,000). In France, the complaints as to the pressure of taxation on industry are universal. The imperial taxation in 1884 was reported at £120,000,000 ($600,000,000) on a population of 37,000,000. Local taxation in France is also very heavy, the *octroi* duties for Paris alone for the year 1884 having amounted to 139,000,000 francs ($27,800,000), in addition to which were other heavy municipal taxes, as, for example, on carriages, horses, cabs, dogs,

market-stalls, funerals, clubs, canals, the keeping of shops, and other commodities and occupations.—*Testimony of J. A. Crowe, British Commission.*

In Italy, according to the British consul-general at Florence (British Commission), the income-tax in 1884 was above thirteen per cent, and the land-tax in some instances as high as twenty-five per cent upon the gross rental. These are independent of local taxation, included in which is the *octroi*, which is also described as "very onerous, and, not being confined to articles of food only, have raised a quantity of small internal barriers, which, in a minor degree, replace the customs barriers of the several small states into which the country was formerly divided."

In respect to Great Britain, the British Commission, as the result of their investigations into this matter, says: "Of the fact of the increase, especially of local taxation, there is no doubt. At the same time it will probably be found that, relatively to the population and wealth of the country, the burden of taxation is now far lighter than in any previous periods."

The published opinions of certain persons of note on the subject are also worthy of attention. Mr. Alfred Russel Wallace, in his book entitled "Bad Times," London, 1885, expresses the opinion that among the most efficient causes for the current depression of trade are "wars and excessive armaments, loans to despots or for war purposes, and the accumulation of vast wealth by individuals."

Dr. Wirth, of Vienna, finds a like explanation in the excessive conversion, or rather perversion, of private wealth for public purposes. Dr. Engel, of Berlin, regards the millions wasted in war by France and Germany, from 1870 to 1871, and continued and prospective expenditures for like purposes, as culminating causes of almost universal business calamities; while, in the opinion of Professor Thorold Rogers, the scarcity and consequent dearness of gold have been the factors of chief importance.

But side by side with all the theories that the "depression" has been occasioned by the destruction or non-production of vast amounts of property by wars, bad harvests, strikes, loss of capital by employment in worthless enterprises, the conversion of an undue amount of circulating capital into fixed capital, and extravagant consumption, should be placed the facts, that statistics not only fail to reveal the existence of any great degree of scarcity anywhere, but, on the contrary, prove that those countries in which depression has been and is most severely felt are the very ones in which desirable commodities of every description—railroads, ships, houses, live-stock, food, clothing, fuel, and luxuries—have year by year been accumulating with the greatest rapidity, and offered for use or consumption at rates unprecedented for cheapness. If lack of capital, furthermore, by destruction or perversion had been the cause, the rate of profit on the use of capital would have been higher; but the fact is, that the rate of

profit on even the most promising kinds of capital during recent years has been everywhere exceptionally low.

Another notable tendency among investigators is to assign to clearly secondary causes or results, positions of primary importance. Thus (general) over-production,* or an amount of production of commodities in excess of demand at remunerative prices, finds greater favor as an agency of current economic disturbance than any other. But surely all nations and people could not, with one accord and almost concurrently, have entered upon a course of unprofitable production without being impelled by an agency so universal and so irresistible as to almost become invested with the character of a natural law; and hence over-production obviously, in any broad inquiry, must be accepted as a result rather than a cause. And so, also, in respect to "metallism" and the enactment of laws restrictive of commerce; for no one can seriously suppose that silver has been demonetized or tariffs enacted inadvertently, or at the whim and caprice of individuals, with a view of occasioning either domestic or international economic disturbances; but, on the contrary, the only reasonable supposition is, that antecedent conditions or agencies have prompted to action in both cases, by inducing a belief that measures of the kind specified were in the nature of safeguards against threatened economic evils, or as helps to, at least, local prosperity. And as crop failures, the ravages of insects, the diseases of animals, the disappearance of fish, and maladministration of government, are local and not necessarily permanent, they must all clearly, in any investigation, be regarded as secondary and not primary agencies. In short, the general recognition, by all investigators, that the striking characteristic of the economic disturbance that has prevailed since 1873 is its universality, of necessity compels a recognition of the fact that the agency which was mainly instrumental in producing it could not have been local, and must have been universal in its influence and action. And the question of interest which next presents itself is, can any such agency, thus operative and thus potential, be recognized? Let us inquire.

* No term has been used more loosely in the discussion of this subject of trade depression than that of "*over-production.*" The idea that there can be such a thing as a general production of useful or desirable commodities in excess of what is wanted is an absurdity; but there may be, as above stated, an amount of production in excess of demand at remunerative prices, or, what is substantially the same thing, an excess of capacity for production; or the term may be properly used to indicate a check on the distribution of products consequent on the existence of such conditions.

PROFESSOR FERDINAND COHN, in a paper on "Vital Questions," considers that we have half solved the riddle of life, inasmuch as we have grasped its mechanism and the physical and chemical forces that set it in motion. But as we still have to face other phenomena and active forces, the full solution of the problem is yet far deferred.

THE TASK OF AMERICAN BOTANISTS.*

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IN discussing the question, What sort of botanical investigation is needed in this country? one might consider two things: First, what are the special problems which from their nature can be studied better in this country than elsewhere; and, secondly, what kind of investigation is best adapted to the present state of our botanical establishments and the capacities of the botanists of this country? In the former case, we are simply to endeavor to contribute something new to the stock of the world's knowledge. In the latter case we shall attempt also to raise the standard of work in this country to that of countries in which botany has reached its highest development. Of these two considerations, the second is, perhaps, the more urgent, because, granting that there are botanical problems which could be solved more easily by botanists living in this country than by Europeans, they will remain unsolved unless our botanists have the time, the means, and the preliminary training for the work. Let me mention a case in point. For many years, botanists wished to know the development of *Azolla*, a genus not found in Europe, but represented in this country by a species common in several districts comparatively near some of the centers of botanical instruction. Naturally, we should have looked to our own botanists for the study of this interesting subject; and it is not flattering to our national pride that the development of our own species of *Azolla* was first made out, not by an American, but by a Swede working at a disadvantage. Other instances might be given in which questions that ought to have been settled by Americans were solved by foreigners. If we are behind some other nations in the quantity and quality of our botanical investigations, what is the reason? Possibly it is not the fault of our botanists, but rather the peculiarity of the conditions under which they are placed; and it would be well, before going further, to consider some of the difficulties which are in the way of those who would like to pursue botanical investigations, for, if some of them are inevitable in the present stage of our scientific development, it may be that others are of our own creation and might be removed.

If, then, we are not doing as much in the way of investigation as other nations, it must be either through lack of inclination, lack of time, lack of means, or lack of the requisite training. I am not inclined to believe that a lack of inclination is responsible for much of the trouble. We have our full share of persons who prefer an inactive self-culture to active work in any special direction, but we also

* Read before the American Society of Naturalists, Philadelphia, December 29, 1886.

have a sufficiently large body of energetic botanists who would gladly do original work if they could. Neither can a lack of requisite training, I think, be regarded as the main obstacle in the way of research. It is true, to be sure, that it has been a serious obstacle in many cases, but it need not be hereafter. If we have not so many well-equipped laboratories of research, so many large libraries and collections as are to be found in European countries, we do have a number of botanical and biological establishments where a student can acquire the training necessary to prepare him for good, original work in botany. However desirable it may be, it certainly is no longer necessary that a young man should go to France or Germany in order to prepare himself for independent work. The great advantage to be obtained from a course of study abroad is the stimulus derived from association with those who devote most of their time to research, as is common in Germany; but, so far as acquiring merely the technical details necessary to one who would carry on independent work or the general knowledge of vegetable morphology, physiology, and histology, which must precede special work in every case, there certainly are laboratories in this country which are quite sufficient for the purpose. Whether a student who can afford to study abroad had not better do so in preference to remaining at home is, of course, another question, and has nothing to do with the fact that one can get a good preparation for work here. If one wishes to pursue botanical investigation, it is his own fault if he does not fit himself for the work by thorough training, unless, indeed, he is too poor; and neither in this country nor any other is it ever going to be possible for one without some pecuniary resources to obtain a training in any branch of science unless he happens to be a person of extraordinary ability.

The two most serious obstacles in the way of research in this country are the want of time and means among those who are mentally well equipped for the work, and who would gladly pursue special investigations were it possible. The lack of time and lack of means are closely related, and, in this country, are unfortunately often found together. If a botanist were only wealthy, he could, of course, find time for research. But, when I speak of lack of means, I refer not to an absence of individual wealth—for we all know that our active botanists have been, and probably always will be, of a class in society only comfortably well off, at the best—but rather to the lack of laboratory equipment, suitable assistants, means of publication, etc. It is an unfortunate fact, too, that those who have the most time at their disposal are usually those away from laboratories and libraries, while those who, like the instructors in the richer colleges, have access to good laboratories and libraries, have to spend most of their time in teaching. Of the two, lack of time and lack of means, I am inclined to believe that the former is the more of an obstacle in the way of research, since it is possible for an energetic, well-trained botanist to do a good deal

even with comparatively poor means; but a well-equipped laboratory, and extensive collections and libraries, are of no avail to him who has not the time to use them. The best work ought to be expected of professional botanists—that is, those attached to the schools and colleges as professors and instructors, rather than from private individuals giving some of their time to botany, because the professors are supposed to be selected for their special knowledge of and interest in botany, and to have better means for work than any, except wealthy private individuals. But if the professors do not accomplish as much as is expected in the way of investigation, their principal excuse—and it is a good one—is that they have no time. But the day is as long in America as it is in Germany, it will be said, and the American professor ought to find time for original work. Unfortunately, most if not all his time is spent in class-work; and his laboratory, his books, his collections, are largely used in elementary instruction of beginners in botany. For this abuse of time and material the public are in part to blame, but, to a considerable extent, the botanists themselves are responsible for the present state of things. In the good old days, the few botanical professors in this country were looked upon as an amiable, harmless set of men who were allowed to give a few lectures every year, and beyond that they were left severely alone. They had an amount of leisure for undisturbed work unknown to the modern professor, and there can be no doubt that their work in investigating our flora did far more for botany in this country than any amount of class-work which they might have done.

But now it is all changed. From being neglected, botany has become a popular study; and it is not enough that a professor should give a course of lectures, but he must have laboratory classes and be prepared to demonstrate the very latest European experiments. If the public now expect far more in the way of personal instruction from botanical professors than they used to, it is largely owing to the fact that botanists themselves have for years been urging the importance of botany as a help in education, and, until recently, have neglected to lay sufficient stress on the value of original work. The educational value of botany is pretty well recognized by the public, and, judging by the last few years, they are rather liberal in providing the means for class-instruction. When it comes to providing the means of research, the question is different; and the trouble is not so much that the public do not really appreciate a good piece of botanical work when their attention is called to it, as that they, as yet, have not the least idea of the amount of time and money required to prosecute research successfully. The unscientific public have an idea that research is a thing of inspiration, or perhaps a sort of recreation to be indulged in after class-work is over, and no conception of the months, and even years, of drudgery required before anything of value is really in print. Not infrequently they regard the ordinary student in a

botanical course as a co-worker with the professor. It has often happened that enthusiastic persons have said to me, "How delightful it must be to have a class of students aiding you in your researches!" Alas! why could they not see that they were hindrances, not aids?

Furthermore, for some most unaccountable reason, the public have the impression that research pays for itself, and therefore does not require endowment. Probably a good many of my hearers have heard the remark, "I suppose you must make considerable out of your scientific papers." Unfortunately, with the exception of text-books of a lower grade, one is only too glad not to be money out of pocket. I fear that you can all bear witness that, with rare exceptions, your published papers have never paid for themselves. It is only after the results of research have reached a homœopathic dilution in some text-book or popular article that they begin to pay. Of such dilutions we already have an abundance, and the more important point is to get something new which will bear dilution. Unfortunately, the public do not clearly see the difference between the original work and the dilution. The former does not pay, and needs encouragement; the latter is a commercial article having a recognized money-value.

A part of the confusion with regard to the paying-value of research in natural history is probably due to the fact that the public see that certain discoveries in physics and chemistry are pecuniarily profitable. But in natural history there are no truths which can be patented. Biological discoveries become the property of the world if the discoverer is fortunate enough to have his work published.

A great gain will have been made if the public can be persuaded that professors in colleges ought to be allowed time for, and be expected to do, original work; and we should assure them that such work is of real value to the world. If the professors are to have time, it can only be by giving them a number of assistants who will relieve them of all the details of laboratory instruction, and possibly the elementary lectures. More advanced work could probably be secured by having one professor with a number of assistants than by two professors without any assistants, provided they both have to give laboratory instruction, as is probable. In a paper which I read to the society at its last meeting, I stated incidentally that one assistant was not enough for a class of thirty or forty men. I did not dwell on the subject at the time, as it was only indirectly related to the question then discussed; but since then a number of persons have expressed their regrets that I had not put the case more strongly, for they regarded an increase in the number of assistants as essential to good instruction and work. It is desirable that there should be an assistant for every twelve students in a laboratory, and it is necessary that there should be one for every twenty men if the work is to be well done. If there are forty students and one assistant, then the professor himself must act as an assistant to twenty of the men, and that means cutting

short the time for other work. In Germany they manage the thing better. The ordinary laboratory work is in the hands of assistants, and the professor, besides his lectures, gives his time to advanced students and original work. The question is, Can our colleges pay for more assistants? They have hard enough work to pay the professors, as a rule, but if the public could be made to see the real need of assistants, and recognize the fact that a professor's salary is not large enough for him to pay for assistance out of his own pocket, perhaps, sooner or later, the money might be provided. As far as the professors and instructors in schools and colleges are concerned, they are not so well able to do original work as formerly, owing to the more laborious methods of modern instruction; but it may be that we are in a stage of transition, and that before long the possibility of overdoing instruction to the detriment of research may be felt by those in charge of institutions of learning.

It may be suggested as a possible solution of the difficulty that there should be some professors for teaching and others for research. That is all very well, if you are not going to give all the money to the one who does the teaching. There is a tendency to regard any salary, no matter how small, as large enough for one who is engaged in research, and the reason usually assigned is absurd, viz., that investigators prefer investigation to any other work. It seems preposterous that the fact that a man's heart is in his work should be made a pretext for paying him less for his work! There are those who prefer teaching to research, and are they paid any the less because they like their teaching? Of the two, the instructor and the investigator, the latter has the more frequent professional calls on his purse even in well-equipped colleges, and statistics are wanting to show that investigators have smaller families to provide for than teachers.

Having considered some of the difficulties in the way of research, we can return to the original question. What sort of botanical investigation is needed in this country? Whatever may be the case in physics and chemistry, it is a fact that the study of natural history in any country passes through stages of development much the same everywhere. In a new country the first work must be almost entirely descriptive and classificatory; and, when this work has reached a sufficiently advanced stage, histology, physiology, and study of life-histories assume more and more importance. In most European countries the first stage has been long past, except as far as some of the lowest forms of plants are concerned, and the greater part of the best work of France and Germany at the present day relates to physiological and developmental subjects. Where do we stand? The question is important, because there is not infrequently a tendency to assume that work in this country is of value only in so far as it is on the same plane and of the same kind as work in Europe. We must be contented to wait a little while, and we do harm rather than good if

we teach that there is no work worth doing except that done in the laboratories of Germany. It often seems as if we were producing a set of precious little prigs, when one sees young men turning up their noses at all those who do any work not involving the most complicated microscopical manipulations. It is well to have our standard high, but it should not be unattainable. We may well set before our young men such models as De Bary, Sachs, Strasburger, and others; but it is just possible that a young man who is determined to be a De Bary, a Sachs, a Strasburger, or nothing, may have to adopt the latter alternative. The trouble is, too many young men assume that the work which they are destined to do is of the highest grade, and they expect to be provided with all the refined apparatus and complete equipment which the leaders of botany abroad possess. They will not begin the simplest thing without an array of reagents which would be the envy of a good many chemists, and the number of staining-fluids which they must have around them would make the rainbow blush at its own poverty. One young man thinks he can't do any work because he has not a Jung microtome. Another has been unable to do anything during a vacation at the sea-shore because he had no osmic acid. To such persons one is inclined to say that he would be thankful if they would *do* anything.

As far as the kind of investigation needed in botany is concerned, we stand where Germany formerly stood, not where she now stands. It is of no use to say that descriptive systematic work is not highly rated in Germany. Our country is so large, and some parts of it are so little explored, that descriptive work has by no means reached its limit. The only question is, how to have it well done; and this brings us to a consideration of the comparative advantages of systematic work and histological and developmental work for different classes of workers. One weak point in our botanical work has been that too many persons have attempted to write on descriptive subjects. Strange as it may seem to some ears, it appears to me that histological and developmental work is what is best adapted for non-professional botanists, including those who do not devote their whole time to the subject, and who as a rule have not sufficiently complete libraries and herbaria to enable them to do descriptive work well. This does not apply, of course, to the older generation of botanists, few of whom have had the training necessary for histological work, but it does apply to the younger generation. Inasmuch as the larger libraries and collections are in the colleges and larger cities, descriptive work, if it is not to be shabbily done, must be done by persons connected with colleges, or by those who are so situated that they can easily visit herbaria and libraries. Furthermore, descriptive work should be in the hands of a comparatively few experts, for long experience is necessary to a good result; whereas the questions in histology, physiology, and development are very numerous, some of them of small range,

and could be done well by careful, conscientious workers, without a long experience and without extensive libraries. As far as equipment is concerned, there are, of course, subjects in physiology which require the elaborate apparatus found only in large botanical establishments, but there are others which do not. The botanist who declares that he can not do physiological work because he has not a large amount of apparatus, would do well to recall the case of a Mr. Charles Darwin, who published something on the power of movement in plants.

If the formal publication of descriptions of new species had better be left to a few experts, the collection of material must be accomplished mainly by those who are not connected with colleges, and who are not in a position to profit by large libraries and herbaria, and we have to consider one very perplexing question, viz., How can collectors receive a suitable recognition of their work? The sneering remark, "He is only a collector," is in many cases grossly unjust. In a large part of our country, the work must for some time to come consist in the discovery of the plants not before known, or not well known, and in such regions the work of the collector is just what is wanted. The man who with a keen eye goes into the field and collects, making discriminating notes on the habits and relationships of plants, is doing a very valuable service for science, and is as truly a botanist, in the best sense of the word, as he who, differently situated, writes descriptive monographs or pursues histological or physiological work. The temptation is for a person who, from his surroundings, ought to be a collector, to suppose that he should go further and attempt to describe the species he has found—a task which, as I have already said, can not well be performed away from large libraries and collections. For one, I honor those active and intelligent men and women who, isolated from the botanical centers, bring together the material of which, in the future, books and monographs are to be made. It is not enough to call them merely collectors. They are botanists in full standing.

If I have said that descriptive botany can be studied best by persons attached to the colleges and the comparatively few experts who have access to large collections and libraries, I by no means think that botanical research in colleges should be limited to this field. The one department in which we are already entitled to hold up our heads and say, "We are as good as anybody," is systematic phænogamic botany. In every other department we are behind hand, and must hurry if we would catch up with our more advanced transatlantic brothers. If I have spent some time in defending the claims of systematic botany, it was because the rising generation have developed an unwarranted contempt for such work. The claims of vegetable physiology on our young men are very great; and when we consider that, as a nation, we are noted for our inventive powers and fondness for studies having a practical bearing, it seems a little strange that vegetable physiology

has not had a larger number of followers with us. Possibly the attractions of physics and chemistry have drawn away some who might have done good work in physiology. I fear that in this department, as in some others, there is a tendency to delay beginning until a first-class equipment has been provided, unmindful of the fact that good work has been done by some who had few costly instruments. Evidently, in the future, physiology is to play a more and more important part in botany, and, as the subject is one which has attractions for the public, they could probably be induced to provide the necessary instruments. It is to be hoped, however, that, in asking for a proper outfit, liberally disposed persons will be given to understand that it is to be used for work and not for ordinary class instruction. Certainly, if the colleges are to keep pace with the times, they must pay more attention to physiology than they now do. It is too much to expect that many of them should be able to support laboratories for physiological research, but we ought to have at least half a dozen such laboratories in the country. We shall probably have to do as they do abroad, where some universities pay particular attention to physiology, while others devote their main strength to other departments of botany.

If we should look to college professors and a few experts for what we still have to be done in systematic botany, and to those connected with the more important laboratories for physiological work of the higher grade, histology and the study of life-histories are subjects of vast extent, and, in most of their phases, can be studied successfully by private individuals as well as by professionals. Especially in the matter of life-histories, persons living in the country, or on the sea-shore, are often more favorably situated than those obliged to reside at the large colleges for the greater part of the year. Since for some years to come the opportunities for research on the part of college instructors must be limited by the excessive and unreasonable amount of ordinary class instruction imposed on them, we must look to non-professionals, to a large extent, to accomplish the work of research necessary to raise us to the level of foreign investigators in the departments just named. The proper direction and utilization of the work of amateurs is of especial importance in this country. The amateur abounds more with us than in any other country with the exception of England. We have an immense variety, from the gay and gallant young man who is going to do something for science, but who now can barely pay his club expenses in winter and run a steam-yacht in summer, down to the impecunious ignoramus who informs you that he is going to write a book, to include all the fungi of this continent, and coolly asks you to give or lend him all your books and specimens, and tell him how to begin. We have the male bore, who kills our time by forcing us to help him kill his; and a copious supply of mild-eyed, sweet-tongued women, whom we can not scold, because they are conscientious, and

whom we can not get rid of, because they really have no other amusement. But the botanist has a slight twinge of conscience when he thinks that the kinds of amateurs of which I have spoken are tolerated mainly in the hope, sweet but prolonged, that they may contribute funds to some botanical endowment. But, alas! the gold-mills of the amateurs grind slowly, and they grind exceeding small. The large sums seldom come from amateurs, but generally from hard-headed business men who do not pretend to be botanists, but who, with a liberality which does infinite credit to us as a nation, give their money for the public good. It is superfluous for botanists to express their admiration of this class of liberal men. We more than admire them —we live on them!

But, fortunately for botany in this country, we have many amateurs of another class. We have many men and women, rich in intelligence, but usually not rich in money. They are scattered all over the country. They are to be found on the coast of New England, in the smaller towns of the West and South, and in the still more recently settled coast of the Pacific. The time which they can spare from their necessary and not unfrequently arduous occupations is given with enthusiasm to botanical pursuits. The spare money which they can command is spent on botanical books which they read. Their collections do not lie idle on the shelves. It is such amateurs as these of which we may justly be proud, and it is by their labors that a large, if not the largest, share of our botanical investigations must be made in the near future, and it is of the greatest importance that their energy and enthusiasm should not be misdirected. In the remoter districts, as I have said, the absorbing work, for some time to come, must be the collecting of specimens and the accumulation of field-notes. In the older parts of the country, including even the Mississippi Valley, it seems to me that the rising generation would make the best use of their opportunities by working out some of the many important questions of histology, and in studying the life-histories of different plants, more especially cryptogams. But the main point is, not to attempt to do too much. The thorough investigation of a small point has a definite value, and does credit to the investigator, but elaborate monographs and far-reaching physiological investigations are only of value when well done, and it is mild praise to say of a man that he has done his work "pretty well, considering," for the really wise man would have considered what he could do well as distinguished from what he could not do well.

But you will probably think that this paper is not like a ball of twine, which, however much it may be twisted and snarled, really has an end. There is much more which I should like to say on the subject; as it is, I have tried to avoid particular specifications as to the subjects of research, which would be interesting only to botanists, but to state broadly some of the difficulties in the way of botanical re-

search, and to indicate the path which promises to be most favorable in the future. If my life proves to be as long as your patience, there will be plenty of opportunities hereafter to consider some points which I have been unable to touch upon to-day.

VARIATIONS IN HUMAN STATURE.

By M. GUYOT DAUBÈS.

THE study of human stature involves several questions of more important interest than that of mere theory or curiosity. It may aid us in learning whether the human race is really degenerating, as some persons assert, by determining whether our ancestors in heroic and prehistoric times had the superior physical prowess that is often ascribed to them. It should teach us whether there are races of dwarfs and of giants, and what are the distances separating the races that most nearly approach those descriptions. We learn from it the exact facts respecting the differences in stature among the people of a single nation, our own, for instance, to which military men attach high value. Other fields of inquiry, of a practical bearing, regard the causes that influence the stature of populations and races in general, and the growth of individuals, from infancy up; and the influence of stature upon the force, agility, endurance, and physical development of individuals. An opinion was current, in the last century, that our ancestors, at some time in the past, were the equals or superiors in size to the largest men now to be found. M. Henrion presented to the Académie des Inscriptions, in 1718, a memoir on the variations in the size of man from the beginning of the world till the Christian era, in which Adam was given one hundred and twenty-three feet nine inches, and Eve one hundred and eighteen feet nine and three fourths inches. But after the first pair, the human race, in his imagination, suffered a regular decrease, so that Noah was only one hundred feet high, while Abraham shrank down to twenty-eight feet, Moses to thirteen feet, the mighty Hercules to ten feet eight and a half inches, and Alexander the Great to a bare six feet and a half. The communication, it is said, was received with enthusiasm, and was regarded, at the time, as a "wonderful discovery" and a "sublime vision."

The complaint about the degeneracy of the human race is not new, but dates as far back as the time of Homer, at least; for the men of his day were not like the heroes of whom he sang. It is not confirmed, but is contradicted by all the tangible facts, and these are not a few. Human remains that are exhumed, after having reposed in the grave for many centuries, as in the Catacombs of Paris, have nothing gigantic about them. The armor, the cuirasses, and the casques of the warriors of the middle ages, can be worn by modern soldiers; and many of the

knights' suits would be too small for the cuirassiers of the European armies; yet they were worn by the selected men, who were better fed, stronger, and more robust than the rest of the population. The bones of the ancient Gauls, which are uncovered in the excavations of tumuli, while they are of large dimensions, are comparable with those of the existing populations of many places in France.

The Egyptian mummies are the remains of persons of small or medium stature, as are also the Peruvian and Mexican mummies, and the mummies and bones found in the ancient monuments of India and Persia. And even the most ancient relics we possess of individuals of the human species, the bones of men who lived in the Tertiary period, an epoch the remote antiquity of which goes back for hundreds of centuries, do not show any important differences in the sizes of the primitive and of the modern man.

Considerable differences will be found to exist, when we compare the statures of the various races of mankind; and it is the exaggeration of this fact that has given rise to the legends of dwarf and giant peoples. Individuals of the supposed dwarf races would appear quite large if compared with real dwarfs. A dwarf much over three feet high begins to lose interest as a dwarf; if he reaches four feet and more, he ceases to be a dwarf, and becomes a "little man." Now, the well-shaped adults of the smaller human races always, with very few exceptions, exceed four feet in height. These races are not, therefore, dwarfs, but simply small races. It is, nevertheless, interesting to study them, and compare them with the larger races. So, in these latter races, men much exceeding seven feet are exceptional, and merit the name of giants. Still, the average of stature in these larger races is much more considerable than in the smaller races; and a man of the average size, among them, would be a giant compared with an average specimen of the smaller races.

Among the smaller races are the Esquimaux, averaging five feet, two inches; the Lapps—men, five feet one inch, women, four feet seven inches; the Akkas seen by Schweinfurth in Africa; the Negritos of the Philippine and Andaman Islands, and Malacca; the dwarf race of Madagascar; and the Bushmen, whose height ranges from four feet five inches to four feet six and three fourths inches.

Among the large races may be mentioned the Norwegians, the Canadians, the North American Indians, the Caffres, the Patagonians, and the Polynesians, the average height of the last two of which is estimated at about six feet. The difference in the mean height of the various human races is, therefore, that between four feet five inches and six feet, or one foot seven inches. The mean between these two numbers is about five feet three inches; and this standard is generally agreed upon by anthropologists as a division line in the approximative classification of the races according to their height. Those are called medium races which average from five and one fourth to five

and a half feet; small races, which are less than five and one fourth feet; and large races, which are more than five and a half feet in height.

From time to time there are found in different populations individuals whose stature departs much from the mean, either in excess—"giants"—or in deficiency—"dwarfs"; and teratology has failed to find adequate explanations of the causes of such variations.

If we may believe the ancient authors, a large number of giants and giantesses attained extraordinary stature, even for persons of that class. Pliny mentions the giant Gabbara, who was nine feet nine inches tall, and two other giants, Poison and Secundilla, who were half a foot taller; Garopius tells of a young giantess who was ten feet high; and Lecat, of a Scotch giant, eleven and a half feet in height. But we may take it for granted that these figures are greatly

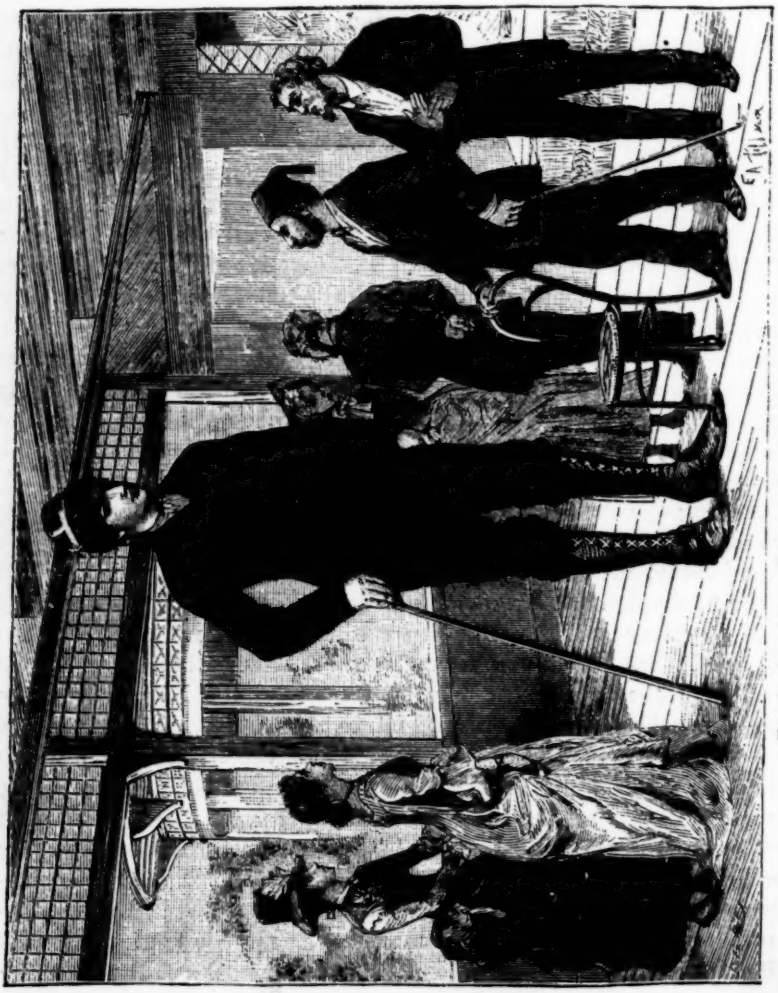


FIG. 1.—AMANAR, A GRECIAN GIANT, 2·36 METRES IN HEIGHT.

exaggerated, while we have a right to regard as authentic giants whose height runs up to eight and a half feet. A giant eight feet high was exhibited at Rouen in 1755. A Swedish peasant, cited by Buffon, was eight feet and eight lines in height, and the stature of the Finnish giant Cujanus was the same; while Frederick William, King of Prussia, had a guard of nearly equal stature. The giant, Gillé de Trent, in the Tyrol, and one of the guards of the Duke of Brunswick, were more than eight feet four inches in height. The Grecian giant, Amanab, now eighteen years old, is seven feet eight inches tall; the Chinese giant, Chang, eight feet three inches. The Austrian giant, Winckelmeier, who was recently exhibited in Paris, measuring eight and a half feet, may be regarded as a specimen of the highest stature attained by the human species. At the opposite extremes may be found numerous dwarfs not more than twenty inches, and some even as little as sixteen and even twelve inches in height; but such dwarfs are only monsters with atrophied limbs or twisted back-bones, or stunted infants, whose age is usually exaggerated by their Barnums. One of the most remarkable dwarfs on record was the celebrated Borulawsky, who was born in 1789, and died in 1837, who was never more than twenty-eight inches in height, was perfect in every limb and proportion, and was bright and intelligent.

The mean between these two extremes of stature is about five feet five and a half inches, and the difference between them is six feet one and a half inch. The mean height is nearly the same with the average stature of Frenchmen. We give an illustration embodying a comparative representation of these extremes, with three intervals between

FIG. 2.—VARIATIONS IN HUMAN STATURE. The giant Winckelmeier, 2·60 metres. A cuirassier, 1·80 m. A man of the average size, 1·66 m. A little soldier, 1·54 m. The dwarf Borulawsky, 0·75 m. A new-born babe, 0·50 m.

them. The portrait of Borulawsky is after a contemporary engraving, that of Winckelmeier from a recent photograph. Beside them are placed a new-born infant of twenty inches, an infantry soldier of minimum stature (five feet one inch), a man of average size (five feet five inches), and a cuirassier of six feet. The illustration comprises all the important variations in human stature.

The conditions that affect the stature of populations and races of men may all be described under one general head—that of nutrition. The size of a population, a race, or a group of individuals living for several generations in the same conditions of environment and resources, is proportionate to its nutrition. Coming to particulars, we find that this nutrition depends, first, on the aptitude for assimilation, which is a question of climate; and, second, upon the facility with which the people can obtain a quantity of food in proportion to their power of assimilation.

It was long believed that climate alone had a great influence on stature; and, in fact, if we regard the white or light-colored races, we remark that the stature is less in climates of extreme temperatures than in temperate latitudes. In the extremely cold Arctic regions, the Lapps, Esquimaux, and Greenlanders are very small; but coming down into more temperate regions and more fertile countries, we find much larger races, like the Norsemen, Russians, Anglo-Saxons, and North-Germans in Europe, and the Canadians and Indians in America. Farther south, and as the temperature becomes hotter, the stature diminishes; a fact which may be verified among the Italians and Spaniards, and which is observed in most of the great regions of the globe.

These variations are not the effect of climate, but are directly dependent, as we have already said, on nutrition. In very cold climates, assimilation is excessive, for the organism needs a large quantity of food to sustain it against the outer temperature. If, in consequence of the rigor of the climate and the limited resources of the country in game and fish, waste is a little superior, or quite equal, to assimilation, the population subject to such conditions must continue small. This is the case with the Laplanders and the Esquimaux of the Arctic islands and the east coast of Greenland. But when game and fish are abundant, the stature of the tribe rises; as takes place with the Esquimaux, whose average height increases as their habitat draws nearer to their southern limit. There the Esquimaux cease to be dwarfs and reach the average height of five and a half feet, or greater than that of the French population. The climate is still rigorous in Canada, and organic assimilation very active, but the country is fertile and food abundant. There the native Indians and the colonists of European origin attain great size and vigor. The Norsemen and the Russians in Europe are in analogous conditions. On what a Russian *mujik* eats in a day a Spanish peasant could subsist for a week. It is to the influence of a keen winter cold and the assimilative power

that results from it that the Anglo-Saxon and Germanic races, and the northern and eastern French, owe their size and strength. As the climate grows warm, and the summer heat becomes excessive, nutrition becomes less active and the mean stature of the population decreases: Spain, Portugal, Italy, and Greece are examples of this. The influence of climate upon stature is therefore a question of faculty of assimilation and of the quantity of available food. For this last reason, the fertility of the soil has a considerable influence upon the size of the population. A well-cultivated country, furnishing abundance of food and cattle, permits its population to acquire a much greater size, strength, and robustness than would be possible to a population living on infertile lands insufficiently supporting its inhabitants. By the same influences members of families in easy circumstances, and standing in the position of old proprietors, are usually heartier than poorer families; the inhabitants of towns than those of the surrounding rural districts.

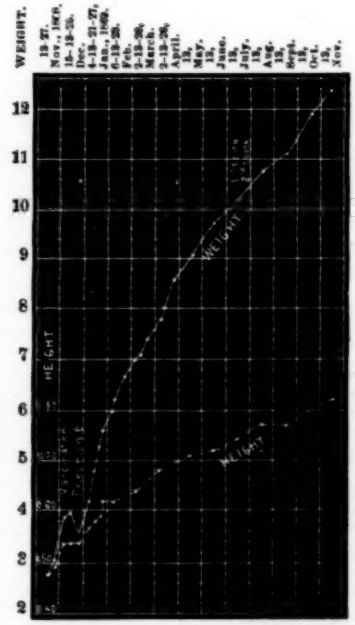


FIG. 3.—CURVE OF THE INCREASE OF HEIGHT AND WEIGHT OF A LITTLE BOY (JEAN LORAIN) DURING HIS FIRST YEAR. (After Dr. Lorain.)

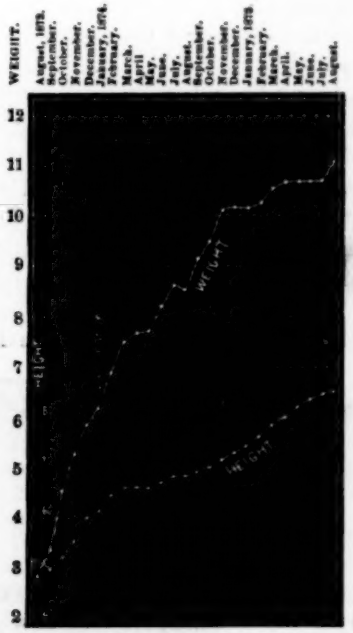


FIG. 4.—CURVE OF THE INCREASE IN HEIGHT AND WEIGHT OF A LITTLE GIRL (JULIETTE R——), DURING HER FIRST TWO YEARS. (After Dr. Lorain.)

(In each of these figures the weight is marked in kilogrammes outside of the diagram, and the rate of growth in height is indicated in fractions of a metre within the first column.)

Famines and frequent or prolonged dearths have the effect of reducing the size of the peoples who are exposed to them. Wars induce the same result, and this not only by the operation of the material disasters and miseries which they occasion, but also through the loss of a large number of the most vigorous and robust men of the nation,

and the enfeebling infirmities and sufferings of those who survive. This is what took place in France during the long period of war that prevailed at the close of the eighteenth century and during the first empire.

Among the causes that operate upon the stature of individuals, considered separately, the first place is given to age. The growth of the infant, of the youth, and of the young man till maturity, is not proportional to their ages. It is more rapid in the earliest years, then keeps slackening till the time when the man, having reached maturity, ceases to grow. His stature then remains stationary till the approach of old age, after which it diminishes till the end of life. Some physiologists have tried to determine the law of the mean advance of growth. Buffon has given, month by month for the earliest infancy, afterward year by year, the growth of a young man. Dr. Lorain has represented graphically the variations in the growth in stature and weight of two children; during the first year for one of them, Jean Lorain (Fig. 3), and during the first two years for Juliette R—— (Fig. 4). In these graphics the lower curve corresponds with the stature, and the upper one with the weight; and they enable us to observe the arrest of growth that may have been caused by the sufferings of the child. In Jean Lorain's curve we see the pause that took place when the subject was vaccinated, an arrest which continued, accompanied by a considerable loss of weight, during a period of pneumonia. The occasion of the appearance of the first two teeth also caused an arrest of growth. We can see in like manner on Juliette R——'s curve pauses of growth in both lines, corresponding with indisposition.

Quetelet has represented the mean increase of stature according to age by a curve. The curve has a clearly-defined parabolical form

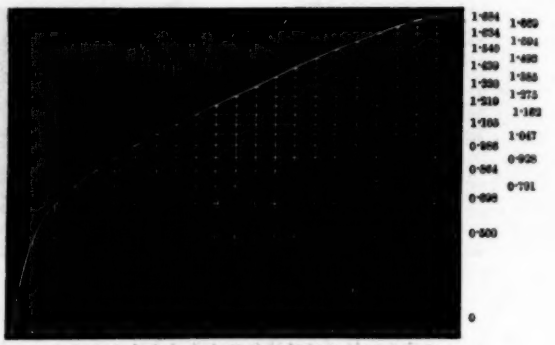


FIG. 5.—PARABOLICAL CURVE, REPRESENTING, BY MILLIMETRES, THE INCREASE IN HEIGHT ACCORDING TO AGE. (From Quetelet's "Anthropometry.")

(Fig. 5). It supposes the child to be fifty centimetres (or twenty inches) at birth. While this curve represents the mean, there are in reality very characteristic differences in the course of growth of children. Independently of the influence of sickness, accidents, ex-

cessive mental labors, anxieties about examinations, all causes that have an influence on growth, there are children whose growth is more accentuated than the mean at some period of their existence; and others, tardy ones, who grow till twenty-five or thirty years old, or even longer. With very many youth, growth does not stop at twenty-one years.

The rate of growth of children varies according to sex. Thus, at the age of eleven and twelve years, boys are larger and heavier than girls; but from that age on the evolution of the girls is more rapid, and they soon overtake the boys and pass them, till the age of fifteen years is reached, when the boys regain the ascendency, while the girls remain nearly stationary. A curious relation has been discovered between the growth of children in stature and in weight. M. Malling-Hansen, Director of the Deaf and Dumb Institution at Copenhagen, has for three years weighed and measured his pupils daily; and he has observed that their growth does not take place regularly and progressively, but by stages separated by intervals of rest. Weight also increases by periods after intervals of equilibrium. While the weight is increasing, the stature remains nearly stationary, and *vice versa*. The maximum of increase of stature corresponds with a minimum period of augmentation of weight. The vital forces appear not to work on both sides at once. These variations are subject to the influence of the seasons. During autumn and early winter, according to M. Malling-Hansen, the child accumulates weight, while his stature increases slowly; but during spring, stature receives a veritable push, while weight increases but little. Some local habits have an influence on the stature. Stendhal remarked that many Roman girls had deformed vertebral columns, or were a little humpbacked, and found that it was the result of a popular belief prevailing in Rome that parents could promote the growth of their children by punching them in the back! A popular custom in some of the towns of Switzerland also affects the development of the children. Mothers are accustomed to give them brandied lumps of sugar to keep them from crying. It has been learned from experiments on animals that alcohol tends to stunt the growth of the young. The habit of some women of the lower classes of drinking brandy during pregnancy in order to give their children fair complexions must likewise have a bad influence on the development of the children. On the other hand, growth is favored by strong food, rich in nitrogen and phosphates, by good hygiene, by play and gymnastic exercises, by plenty of air, and by all the causes that contribute to make children strong and vigorous.

One of the less recognized agencies affecting stature is fatigue, under the influence of which the height diminishes. A soldier, for instance, is perceptibly taller before than after a forced march; when the body is fatigued it gives way, the cartilages lose their elasticity and become thinner, and the fatty and fibrous cushions, which give

spring to the organs of locomotion, become less supple and more attenuated, all of which contribute to the diminution of height. Carrying burdens on the head or shoulders leads to the same results. If to an excessive fatigue is added privation of sleep, organic reparation can not take place, and the causes which contribute to the diminution of stature accumulate and effect in the total a decrease which is relatively considerable. This fact is known to the tricksters who practice upon young men liable to military service so as to secure exemptions for them. If the men are only a few centimetres over the minimum standard of the service, these practitioners put them through a variety of fatiguing exercises, with carrying of burdens and privations, etc., till they succeed in reducing them below the minimum and causing them to be rejected on examination. The same influence of fatigue is also felt in ordinary life. The simple standing position, walking, and riding, all contribute to a reduction of the height. We are all taller in the morning than in the evening. Professor Martel made a communication on this subject to the German Surgical Congress held in Berlin in 1881, and presented a number of measurements, from which he concluded that men's statures varied perceptibly according to the hour of the day. The variation differs according to occupations, being less in the case of those which are sedentary.

The height of the adult continues stationary during mature age, but begins to diminish at about fifty-five or sixty years. The decrease is independent of the curvature of the vertebral column, and is exhibited upon robust men who still hold themselves up straight. It depends upon several causes, among which are a modification of the neck of the femur, flattening of the fatty cushions, with gradual ossification and decrease in thickness of the cartilages of the joints, particularly of those of the vertebral column.

Physical aptitudes are various according to stature; and we are able to draw important conclusions, particularly with reference to fitness for military service, from the determination of them. The bodily vivacity of small men is very much greater than that of large men. The man of small stature is nearly always quicker and more alert than a man who is tall and stout in proportion. This should be evident, for such a man has less weight to displace when he is moving, jumping, or climbing; while it has been proved, by many experiments on animals, that the strength does not increase in proportion to the weight. Two horses weighing together three quarters of a ton can perform much more work, particularly if it be work involving rapidity, than a single horse having the same weight. A similar difference exists in the power of one large and stout man and two small men. The ratio of muscular energy to the pound of living weight is much greater with small or middling-sized men than with very large ones. The length of the limbs of the latter necessarily occasions an amplitude in his motions that makes execution slower. Length of limbs also contributes to a

waste of strength. We can compare the arm, for instance, with a lever, the fulcrum of which is at the shoulder-joint, the point of action at the hand, and the power in the muscles. It is evident that the larger the arm of this lever is, the more energetic will the muscular effort have to be. The large man's power of endurance is less than that of the middling-sized man, because not only of the personal weight that has to be carried, but also on account of the difference in the proportional development of the respiratory system. The power of endurance may be estimated in a man at rest by taking the proportion between the height and the circumference of the breast at the height of the mammary processes. The larger the proportion of the latter element, the greater will be the power to resist fatigue. The French marine formerly accepted only those men whose breast-measurement was at least half their height. The same degree of development is required in Switzerland, and the acceptance of young men who can not display it is adjourned from year to year. Thus, looking at military aptitudes, it is middling-sized or small men that offer the greatest energy, power to resist fatigue, and activity in battle; and of this kind is the popular type of the French soldier—the *petit chasseur*, or the soldier of the line.—*Translated for the Popular Science Monthly from La Nature.*

THE PANAMA CANAL.

By STUART F. WELD.

NOT a little skepticism, and even some hostility, have existed among us as to the Panama Canal; and, perhaps, any other nation in our situation would have entertained similar sentiments. It is worthy of note, however, that the nation was not lacking in tact when it refrained from showing any such feelings during the recent visit of M. de Lesseps. De Lesseps was the guest of the United States; and it is hardly civil to criticise one's guests. He was here not as a representative of the Panama Company, but as President of the Franco-American Union. Upon the death of the first president, Edouard Laboulaye, he had been elected to this position. This Union had collected the funds destined to carry out the design of Bartholdi, and it naturally devolved upon its head to make the presentation speech on the 28th of October, the day of the inauguration of the statue. The Panama Canal had no connection with the Statue of Liberty; but every one thought of De Lesseps as the constructor of one interoceanic canal and the projector of another. It was natural, therefore, that something should be said, after all, about the Panama enterprise. A banquet was offered to De Lesseps by Cyrus W. Field, October 27th, the day before the ceremony upon Bedlow's Island. On the 2d of November, one was tendered him in like manner in Philadelphia by

George W. Childs. On the former occasion, Mr. Field, having referred to the Suez Canal and the obstacles met with in its construction, said with regard to De Lesseps and Panama: "As that work is now in progress, it may be presumptuous to speak of what is in the future. I can only say that I learned in Egypt that it will not do to say that anything is impossible to M. de Lesseps, and that he has with him the ardent hopes of all Americans that he may not taste of death till he has carried out his last and greatest work, which will link his name imperishably with this New World as it is already linked with the Old."

Sentiments of this sort, in sympathy with the undertaking rather than opposed to it, were expressed at the banquet in Philadelphia. De Lesseps, in the course of his visit, listened rather to what admirers or sympathizers had to say than to utterances of another description. But these compliments are not a reflection of the whole of public sentiment. Many Americans, having assumed in the beginning an antagonistic feeling toward the enterprise, are still disposed to keep that feeling and to support it by regarding largely if not chiefly the difficulties to be met. It may not be out of place to see how far this attitude is justified by the physical elements of the vast undertaking and the financial prospects of the Panama Company; we may also glance at facts, perhaps at the opinions of authorities, as to the desirability of some sort of interoceanic passage.

In 1883 Admiral Cooper, then in command of the United States naval forces at Panama, submitted to the Navy Department a report upon the condition of the enterprise; in this he says: "The whole undertaking is so gigantic that one can not believe that it will soon be finished; but I am impressed with the fact that the French are thoroughly in earnest, and that if they fail to finish the canal on account of want of funds the work done by them will be well done, and will be so extensive as to always give this route great advantages over any other." He also observes: "Opinions have been expressed that the work is being delayed by unnecessary attention to details and in making provision for possible emergencies; but this careful preparation for the great undertaking strengthens my belief that the canal will ultimately be finished more than anything else."

These opinions were expressed some four years ago, when hardly a beginning had been made in the matter of excavation, less than one million cubic metres having been removed. The amount removed up to the 1st of January of the present year was thirty millions, about a quarter of the whole.* It is safe to say that since 1883 the chances

* This estimate, twenty-five per cent, implies the completion of the work as a sea-level canal. As much as this, however, we ought not to assume. Should the work be completed as a lock-canal the requisite excavation would be much less.

With regard to the total excavation, estimated by the company at 120,000,000 cubic metres, authorities are not agreed. Lieutenant Kimball, United States Navy, from whose

of the completion of the work have improved. Yet it is not to be assumed that De Lesseps and the present company will be able to complete it. Only recently they failed to get the authorization of the French Government to raise 600,000,000 francs by means of a loan

late report to our Government one or two extracts are to be taken, speaks doubtfully upon this point, but seems to think it likely that the excavation will reach 135,000,000, or perhaps more. He observes that the slopes adopted by the company are two to three in soft earth (two of vertical dimension to three of horizontal) and two to one in rock; these he thinks not sufficiently gradual, and hence his larger estimate.

With regard to the amount excavated, January 1, 1887, 30,000,000 cubic metres, it may be added that, according to two authorities favorable to the enterprise, Hon. John Bigelow and M. de Molinari, who inspected the works last year with De Lesseps, a somewhat lower figure may be assigned. They give as the amount excavated at the time of their inspection in February, 1886, 14,000,000 cubic metres instead of 19,000,000, the figure of the company. De Molinari, however, remarks that these 14,000,000 cubic metres do not include the whole excavation. This he puts at 17,000,000, only 2,000,000 below the company's reckoning. He explains that the 3,000,000 excluded refer to accessories—the excavation of roads over which to carry the extracted material, etc. Such parts of the excavation, he seems to have thought not comprised in the estimate of 120,000,000 cubic metres. His carefully-prepared letters, published in the "Débats," and which relate both to the Panama enterprise and to the economic condition of several of the West Indies, have recently appeared in book-form. The author, well known as a writer upon political economy, dedicates his work to De Lesseps.

Finally, it may be remarked that the entire excavation for 1886 reached 11,727,000 cubic metres, an average of almost 1,000,000 per month. The excavation for the first three months of the present year is as follows:

January	1,051,000	cubic metres.
February	1,286,000	"
March	1,100,000	"

The decrease in the excavation for March is for the most part only apparent; for, as the work is reckoned from the 25th of each month to the 25th of the next, March thus gets twenty-eight days while February gets thirty-one. It is safe to conclude that the excavation for 1887 will equal, and probably exceed, that for 1886. At the lowest estimate the amount removed up to July 1st may be set down at 36,000,000 to 37,000,000 cubic metres; an amount which may be the more readily assumed since the work usually progresses more rapidly during the first six months of the year, the dry season, than during the wet season which succeeds. The excavation for February, 1,286,000, is seventeen per cent higher than that for any other month since the work began.

The following table, taken with the exception of the figure for 1886 from De Lesseps's last annual report, gives the average monthly excavation each year:

1882	16,245	cubic metres.
1883	215,300	"
1884	617,054	"
1885	658,708	"
1886	977,250	"

Possibly 1887 is to show a considerable increase over 1886, as 1886 did over 1885. We should remember that, owing chiefly to the improvements effected in the machinery used at Suez, more excavation was effected during the last three years than during the previous seven. If we could allow ourselves to make such a calculation for Panama, the work might be finished in 1890. Mr. Bigelow is of opinion that upon this contingency, the progress of invention, De Lesseps counts at the present day; and, in fact, the work at Panama has already been accelerated in this manner.

with lottery drawings attached. It was by just this method—a lottery loan—that the Suez Canal was finished, but the French legislators of 1886 hardly took the degree of interest in the Panama scheme which those of 1868 did in the Suez. Only eight votes were cast against the bill of 1868, and this enactment carried the work through to its completion.* The result in the present case has been that De Lesseps was obliged to go upon the market and raise about one third —200,000,000 francs—the amount asked for, upon comparatively onerous terms. This sum, added to 75,000,000 francs, the last quarter of the stock capital, called in in September, will enable him to continue the work for one or two years. It remains to be seen whether, prior to the expenditure of these sums, a renewed application to the French Government will meet with better success. It should be remembered, after all, that the French Government favored the application of the company. It introduced a bill based in its essential features upon the bill of 1868. Opposition existed not in the ministry but in the Chamber, and it is possible, to say the least, that upon a subsequent occasion the ministry and Chamber may find themselves in accord.

It may, perhaps, be considered doubtful whether the present company is to complete the work, and whether the French are to maintain the financial control they at present possess. But it can not be denied that powerful incentives must influence the French Government and the French people toward the support of the company, and the keeping of the work in De Lesseps's hands. In no way can the weight of such considerations be shown better than by the following extract from the late report of Rousseau, the commissioner of the French Government. He inspected the work in February, 1886, and at the close of his report says:

"In fine, I consider the cutting of the Isthmus of Panama a possible work, and that at present it has been carried so far that it can not be abandoned. . . .

"Such an abandonment," he goes on, "would be in fact a veritable disaster, not only for the stockholders, who are nearly all French, but as regards French influence all through America. . . .

"It does not seem to admit of doubt that, if the affair failed in the hands of the French company, it would be immediately taken up by a foreign company to prevent the fruits being lost of the enormous sacrifices made and the results obtained. . . .

* It is true that the amount of the loan asked for in 1886, 600,000,000 francs—the calculation of the company being that 600,000,000 added to the 600,000,000 already spent or still disposable would complete the work—much exceeds the loan obtained for Suez, 100,000,000 francs. But we may remember that the commerce and wealth of the world have vastly increased available capital; and, moreover, the astonishing financial success of the Suez Canal ought to serve as a powerful stimulus. According to the estimate of the Paris Congress, Panama was to cost double what Suez did. But the commerce of the world will have more than doubled, reckoning from 1869, before the work at Panama is completed.

"The Panama Company, because of the names and past of the men who direct it; the eminent advisers whom it possesses; the grand and in some sort humanitarian character of the work it pursues; because of the serious efforts which it has already made, and is still making successfully to complete the work, deserves in a special sense the regard of the Government."

Much has been said as to the unfavorable character of the report of Rousseau. Although not published in full, it is understood not to be in every respect what De Lesseps would have wished. Yet, judging from the passages quoted, it is plain that the author is in no sense indifferent to the fate of the undertaking. He recognizes the stake possessed in it, alike by the French people and the French Government.

It seems, therefore, probable that the French will make strenuous efforts to finish the canal; reports, on the other hand, have been current as to the calculations of English, German, and American capitalists, in view of a possible collapse. A year or two will probably determine the success or failure of the company. It has, however, a resource wholly within itself—the reduction of the cost by making the canal with locks instead of cutting it to the sea-level. This is the course recommended by the commissioner of the French Government, Rousseau. Upon such conditions the assistance of the Government might be more readily obtained than if the company should persist in endeavoring to carry out its original purpose. In case the lock solution should be adopted, it is to be kept in mind that such a canal at Panama possesses one unquestioned advantage over one at Nicaragua: the former can, while the latter can not, be converted into a sea-level canal.

It may be observed, besides, that the only plan for a canal at Panama ever submitted by the engineers of the United States, that of Lull and Menocal, in 1875, is a plan including locks. De Lesseps is not a man to neglect his own interests; he might be ready enough, no doubt, to take a hint, never mind from what source. *Fas est ab hoste doceri.** Should this design be adopted, so as to get the canal through, and should the undertaking prove remunerative, capital might be subsequently raised to deepen the work to the sea-level.

One common error in estimating the cost of the canal here deserves attention. The preparatory expenses of such an undertaking are large. A heavy outlay is required before much more than a beginning can be made in the matter of excavation. The Hon. John Bigelow, in his report upon the status of the enterprise, submitted to the New York Chamber of Commerce in April, 1886, gives a table of the expenses down to July, 1885. It is taken from De Lesseps's annual report of that date. In it the expenditure up to this point is put down at 368,-

* This is not a point to be pressed. Wyse and Reclus prepared two plans for a ship-canal at Panama, one a sea-level plan and one with locks. The former was adopted by the Paris Congress. It was plain, however, that should this method of execution prove too expensive, the company might fall back upon the other alternative.

000,000 francs, while the amount set down under the heading, "clearing the surface of wood and stumps, installing machinery, and excavation," amounts to but 115,000,000 francs. This is less than a third of the whole. Mr. Bigelow observes that this "last item only, and that partially, represents work on the canal." He assumes that this 115,000,000 francs represents the cost of about one fifth of the excavation. Now, it has been customary for the critics of the undertaking to argue thus: If one fifth of the excavation costs 368,000,000 francs, it is easy to see that the whole will cost about 1,800,000,000 francs, a sum greatly in excess of the estimate of the Paris Congress. This estimate was 1,070,000,000 francs.* But the above method of computation is obviously erroneous. Mr. Bigelow, referring to it, says: "It would be very misleading to infer the cost of the work remaining to be done from the apparent cost of what has been done. Fully two thirds of the expenses already incurred are in the form of plant." He points out in like manner that it would be "scarcely more fallacious" to infer that because one fifth of the excavation had been made for 115,000,000 francs, the money required to complete it would be only four times that amount. The work which remains is much more difficult than what has already been done. As the trench descends to lower and lower levels, it becomes more expensive to get rid of the material excavated.

Another criticism of a somewhat vague and yet serious character is brought against the undertaking. It is said that lavish expenditures, a reckless disregard of prudence and economy, have characterized the work. Upon this point also Mr. Bigelow's testimony is not without weight. He says: "No doubt some of the money has been injudiciously expended, but what great work, whether of a private or public character, has escaped this reproach? Taking the waste through these channels at the largest presumable figures, the inconsiderate expenses of the average individual all over the world would probably represent a larger percentage of his aggregate expenditure." †

* It is not to be inferred that even so large a sum as 1,800,000,000 would preclude all chance of reasonable profits. A statement upon this point was made at the Geographical Congress of Hamburg, held in April, 1885. One session was devoted to a lecture upon the Panama Canal, given by a Dutch engineer, Van Nehus. He said: "According to the learned report of the French economist, Levasseur, the probable annual tonnage of the canal would be 7,250,000, and this at the rate of fifteen francs per ton, after deducting 3,000,000 francs for maintenance, would afford an income of 105,750,000 francs. This would give a satisfactory interest, even for a stock capital of 2,000,000,000 francs."

† "The Popular Science Monthly" for April, 1880, in an editorial discussion of the canal question, makes the following observation. The editor, referring to the fact that the foreign holders of American securities have been not unfrequently, by skillful manipulators defrauded of their just dues, says that De Lesseps "defies the world to show that a centime of the funds contributed to the Suez Canal was misappropriated or stolen."

Of the contrast which, according to the opinion of some, exists between the financial management of Suez and that of Panama no sufficient evidence seems to exist.

Before leaving Mr. Bigelow's exposition of errors, into which unless upon our guard we might perhaps be led, it may be observed that his report, prepared after a personal inspection of the work, is one of the most judicial documents published upon the subject; and those desirous of forming an impartial estimate would do well to acquaint themselves with it. To indicate the importance attached by Mr. Bigelow to the completion of the work we may cite the passage which follows. He observes that the French, especially people of moderate means, possess for several reasons extraordinary faith in De Lesseps; partly because they know that De Lesseps does not "job" with the securities of the undertaking; partly because of the financial success of the Suez Canal; and partly because the completion of the Panama Canal under De Lesseps's auspices "would rank among the half-dozen largest contributions ever made to the permanent glory of France."

These references to Mr. Bigelow's report may be supplemented by an extract or so from the latest report made to our Government on the subject, the "Special Intelligence Report" of Lieutenant W. W. Kimball, United States Navy, who inspected the works about the same time as Mr. Bigelow, early in 1886.* Lieutenant Kimball says: "That with a sufficient expenditure of money, time, brains, energy, and human life, the canal can be finished, is self-evident, but it would be idle for me to attempt to estimate the necessary quantity of all or any of them. Too many of the prime data for calculation are unknown quantities."

If such a statement on the part of Lieutenant Kimball makes us cautious in accepting the present, or at least recent, estimate of the company as to ultimate cost, 1,200,000,000 francs, it may make us equally cautious in accepting the pessimistic, larger estimates which appear from time to time.

As regards the plans Lieutenant Kimball says, "As might be expected of the work of the eminent engineers who have made the plans, the design is almost above criticism."

With reference to the proposed dam at Gamboa, by which the freshets of the Chagres River are to be controlled, a work as to whose impracticability or insufficiency much has been said, the writer observes, "The engineering difficulties are to me not at all patent."

This exhaustive report is not without strictures upon the course of the company in certain cases. Lieutenant Kimball, in particular, is disposed to think, while holding that the plans for the control of the Chagres River are practicable enough, that their execution has been unadvisedly delayed; floods have at certain points carried into the excavation fresh deposits which will require to be re-excavated.†

* The writer is indebted to Lieutenant Kimball for permission to make use of the proofs of his report.

† Since the above was written, a dispatch from Washington states that an inspection of the canal was made in March by another officer of our navy, Lieutenant C. C. Rogers.

In concluding these considerations, it may be remarked that it is less than ever safe to try to fix at present the cost of the undertaking. The company is considering the advisability of executing it upon a less extensive and costly scale in certain respects. Possibly, though the company has for the present decided against it, the lock plan may be adopted, and, until such practical questions are finally settled it is impossible to estimate the expense.

Some may still ask, Is a canal or a ship-railway worth building, after all? Even Admiral Ammen intimated doubts as late as 1879, after the decision of the Paris Congress, as to whether the time had come to cut the Isthmus.* It may not be hard to satisfy ourselves on this point. In a report submitted to the Navy Department in 1866 by Admiral C. H. Davis, an estimate is given of the tonnage which would have used a canal had one been in existence, as well as of the loss inflicted upon commerce because of its lack.† The former estimate is 3,094,070 tons, which agrees pretty well with the estimate of the Paris Congress for the year 1879, if we assume the rate of annual increase from 1866 to 1879 which the Congress adopted. Admiral Davis's estimate of the loss annually experienced by commerce was $49,530,208. These estimates, made over twenty years ago, would be evidently too low for 1887. But even should we assume that in the course of the past twenty years no increase of traffic had occurred, a result sufficiently surprising would be arrived at. The loss to commerce in four years would amount to $200,000,000, about the cost of the Panama Canal according to the estimate of the Paris Congress. This simple calculation shows the importance of the work. Mr. Bigelow, in his report, already quoted, says, with reference to the Panama Canal, "Were all nations to contribute toward its construction in any equitable proportion to the advantages they would derive from it, the stock would be as difficult to obtain as the golden apples of Atalanta."

We have thus far supposed that the tonnage which would pay dues to a canal, as well as the loss which the lack of a canal occasions, has not increased for the past twenty years. It is true that Admiral Davis's computation of this increase would lead us to exaggerated conclusions. According to this estimate, the tonnage which would use a canal would double every ten years. The estimated loss ex-

According to this dispatch, Lieutenant Rogers states in his report that the company did as much work during the past year as it had done in all the preceding years—which seems to be an exaggeration. While he doubts somewhat that the present company will be able to complete the undertaking, he thinks the ultimate completion of it is certain, and he considers it better to finish the Panama Canal than to spend money on the Nicaragua project.

* "The American Interoceanic Ship-Canal Question," by Admiral Ammen, p. 66.

† These computations, as well as an estimate of the supposed rate of tonnage increase, were originally made by Frederick M. Kelley and published in a pamphlet in 1859. They are incorporated by Admiral Davis into his report.

perienced by commerce being for 1866, $50,000,000, would be for 1876, $100,000,000; and for 1886, $200,000,000. According to this computation, the annual loss to commerce at present is equivalent to the cost of the Panama Canal as estimated by the Paris Congress. Every year, if we may assume the above data, money enough is wasted because we do not have a canal to build one! Such a calculation is, however, in excess of the truth. The computation of Levasseur, the one adopted by the Paris Congress, that sixteen years would be required to double the tonnage, is more moderate and much more reliable. According to this, if the loss in 1866 may be set down at $50,000,000, the loss in 1882 would be $100,000,000. It is quite possible that the truth lies between the estimates of Levasseur and Davis. Over a page of Mr. Bigelow's report is devoted to the estimates of a commercial journal of Paris, The "Revue-Gazette," and these exceed the estimates of Levasseur. Authorities differ but even estimates not among the highest show that some interoceanic route for ships is one of the greatest commercial needs of our times.

It seems almost superfluous to ask for the indorsement of names to an enterprise of such great utility; but, as the testimony of experts has weight with many minds, a few authorities of unquestioned competence may be cited. Among such may be reckoned Admiral Ammen. Appointed by General Grant one of a commission of three to report upon the interoceanic question, he was subsequently sent by our Government to represent it at the Congress of Paris. In his volume upon the interoceanic question, he observes that the result to be attained is "the grandest that man is capable of achieving for the amelioration of the commerce of the world." *

Not less significant is the opinion of the late W. W. Evans, an American engineer of distinction. Of Mr. Evans, Admiral Ammen remarks, in a recent publication, that his name is known all over the world. Mr. Evans wrote in 1879 that this canal matter was "the most important matter in the line of progress now before the world." † Such a statement may perhaps lead us to ask, Does not the ascription to the canal of such a preponderant influence connect itself with questions of international law? Admiral Davis, in his report, already cited, quotes from a writer, whose name he does not give, this statement, viz., that the cutting of the Isthmus would prove "the mightiest event probably in favor of the peaceful intercourse of nations which the physical circumstances of the globe present." Assuming that it is desirable that the peaceful intercourse of nations be promoted, another question naturally presents itself: Would it be promoted or not by the establishment and recognition in the cases of Suez and Panama of the neutrality of these works? This is not an occasion to discuss such a

* "The American Interoceanic Ship-Canal Question," by Admiral Ammen, p. 67.

† "Journal of the American Geographical Society for 1879," p. 144.

point. It may be enough to indicate the significance which attaches to it.

Among other authorities may be named Admiral Davis, Professor Nourse, United States Navy, who prepared for the department in 1883 a report upon the Suez and Panama Canals, Lieutenant Maury, General Grant, and Senator Windom. In the Senate, February 28, 1881, the latter observed, after referring to the significance of the work and the demand for its execution, that it was a wonder it had not been sooner undertaken. Pitt, Jefferson, and Humboldt, are men of a former generation who interested themselves in the problem.

As the work is at present in French hands, some reference to French authorities might not be out of place. The curious may consult to advantage an address delivered by Renan, April 23, 1885, when De Lesseps was received by the French Academy. Renan, after assuming that the possible inhabitants of the planets may have better telescopes than ours, alleges that they might judge of our civilization by the state of our isthmuses. "A planet," he continues, "is not ripe for progress till all its inhabited parts are brought into intimate relations, each with each, so as to constitute a living organism, so that no part may be able to enjoy, or suffer, or act, without feeling and reaction in all the rest."

Nor is it to be said that this reference to the cutting of isthmuses as a touch-stone of civilization is an empty compliment, one which might fitly, perhaps, find its place in a eulogistic address. The testimonies adduced as to the division of the American Continent are explicit enough. It is safe to say that if the completion of any enterprise in course of execution to-day is loudly called for by the interests, even the necessities of *all* states, it is the enterprise at Panama. The French may not be able to complete it—if by them it is to be completed—as soon as their wishes and certain possible political calculations have designated. They may not celebrate its inauguration, and at the same time celebrate the centennial of the Bastile and the era of the Revolution. Let us hope, at all events, that the inauguration is not to be long deferred.

The proper spirit in which this great enterprise ought to be regarded is perhaps set forth in the following lines from a German source. The Gazette of the Administration of the Railroads of Germany, published in Berlin, expressed itself in a recent number thus:

"In conclusion, we should not fail to express a hope that the courageous builders of the canal will succeed in overcoming all obstacles, so that a great work, which will be the pride of the engineering art of to-day, and even of the nineteenth century, may be successfully finished by those who thus far have borne the entire labor and the entire weight. If the present company should fail, certainly a second would be formed which would inherit the advantages and experiences of the first, without having paid for these at its own risk

and by its own work. The undertaking is chiefly in French hands, and we Germans have but little interest to favor the extension of French glory and success; but the divergencies which exist between nations should disappear in face of the great spirit of enterprise, which animates the director of the canal, M. de Lesseps, and in face of the private capital invested, which, though it be invested to promote private interests, has a general interest as well." *

Of such views it is safe to say that they are at least deserving of consideration. They are much to the credit of the writer, whose breadth of view and liberality of judgment alone enabled him to pen them.

THE NORTH AMERICAN LAKES.

By ISAAC KINLEY.

IN America, as in the Eastern Continent, the North is the land of lakes. A line from the mouth of the St. Lawrence to the western end of Lake Erie, and thence to the mouth of the Mackenzie, lies through and near a succession of lakes unequaled in number and aggregate area by any other like extent on the earth. The great North American depression, extending northward from the Gulf of Mexico, bifurcates at about the fortieth parallel, one branch trending northeastwardly to the Atlantic Ocean, and the other northwestwardly to the Arctic, lying nearly at right angles to each other, and in approximate parallelism to the mountain-ranges and shore-lines of the continent.

The forty-second parallel holds, to the north of it, nearly all the North American lakes, while to the south are numerous lake-basins, some of them rivaling even Superior in extent. These have been drained of their waters by the deepening channels of their effluent streams; or, as in the arid regions of the Southwest, by evaporation.

If we define a lake as, what geologically it actually is, *a local depression of the surface*, and treat the pressure or absence of water as only one of its accidents, we shall find the South, no less than the North, to be a land of lakes.

Lake-basins may be due—

1. To local sinkings of the surface.
2. To excavations, notably by glaciers.
3. To the extinction of volcanoes, their craters filling with water.
4. To the breaking down of cave-roofs by earthquakes or other causes.

To the first and second of these agents are probably due nearly all the existing North American lakes, in some the one and in some the

* "Bulletin du Canal Interocéanique," December 1, 1886.

other acting as principal. In all the larger lakes there has evidently been a local sinking of the surface, the glacier having been only auxiliary. The numerous small lakes in Middle and Western New York lying in the direction of the glacier-flow, and having frequent groovings on their adjacent walls, have been credited wholly to the glacier. But, as nearly the whole of this lake-region lies within the Niagara limestone formation, it is not improbable that the falling of cave-roofs may have greatly aided the work of the ice-plow. Many small lakes and ponds, as in Kentucky, Tennessee, and Southern Indiana, are due wholly to the falling down of cave-roofs. In South-Eastern Missouri and Eastern Arkansas are lakes and lakelets where these roofs were shaken down by the earthquake of 1811. Lakes Borgne and Pontchartrain have been captured from the Gulf by the delta of the Mississippi; while numerous small lakes, called bayous, have been formed by changes in the river-bed, the deposit of sediment at both their inlets and outlets having kept them filled with water. Crater-lakes are not infrequent. These basins, but containing no water, abound in New Mexico, Arizona, and Southern California, while many of the beautiful lakes of the Italian Peninsula are but the filled craters of extinct volcanoes.

Why is the North the land of lakes? In order intelligently to answer this question, let us see what has been going on at the South. Between the Alleghanies and the Blue Ridge is a long, narrow valley extending nearly the whole length of these parallel ranges; and, but for the breaks in whose walls, the whole extent must have been a basin of water. At Harper's Ferry, the Potomac, and near the Natural Bridge, the James River, have broken through the Blue Ridge carrying the waters of the upper half of the valley to the Atlantic. Farther to the south the Kanawha and the Tennessee drain the lower half into the tributaries of the Gulf of Mexico. These last-named rivers have also broken through the Cumberland Mountains, draining another considerable valley between these and the Alleghanies. Could these several outlets be closed, as they probably once were, large lakes would again rapidly form, and the work of abrasion and drainage begin anew. Could the Knobs and the Muldro Hills unite again at the falls of the Ohio, a large shallow lake would form, covering parts of Ohio, Indiana, and some of the fairest portions of Kentucky. Should the bluffs of the Wabash come together at the mouth of the Salimony, another shallow lake would result, whose outlet would probably be the Maumee. Commencing at Richmond, Indiana, itself situated in a small lake-basin, and thence northeastwardly half-way across Ohio, is a succession of shallow depressions once filled with water, and through which still flow the streams whose unceasing work has cut through their margins and emptied them of their contents. In many of these ancient lake-basins the draining is not yet completed, the lowest parts being still marshes or ponds of water. The Mohawk and the Con-

necticut flow each through a bead-roll of small lake-basins, walled around by solid rock. Through their margins the rivers for untold ages have been deepening their channels until the lake-bottoms have become dry land, and the homes of men. The Great Lakes themselves have, from a like cause, been much reduced from their former dimensions. The evidences are abundant that Lakes Michigan, Erie, and Huron are but the relics of what was once a large body of water, covering all the intervening and much of the adjacent lands. The work of depletion is still going on. Not only is Niagara deepening its channel and sinking thereby the surface of Lake Erie, but by the gradual recession of the falls a much greater work is prophesied. It is only a question of time when Erie will be robbed of its waters, and the other Great Lakes reduced to insignificant parts of their present dimensions. Lake Pepin, now but an expansion of the Mississippi, was once a much larger body; and Peoria, a similar widening of the Illinois, once spread over the adjacent level lands equaling in area that of Lake Champlain.

Doubtless, in many of these lake-outlets, natural fractures and marginal depressions have not only given direction to the effluent streams, but greatly aided in the work of abrasion. The evidence, however, of the former greater extent of these lakes is abundant and apparent. The railroad from Lafayette, Indiana, northward cuts through several low lake-margins, marking the gradual retreat of the waters; and runs within sight of several sand-hills similar to those on the lake-shore near Michigan City. There are evidences that the Illinois was once the outlet of Lake Michigan and the Wabash that of Erie, carrying the waters of these lakes to the Gulf of Mexico.

It is now generally conceded that the whole northern part of the continent, reaching southward in some places to the thirty-eighth parallel, once wore an ice-cap of immense thickness, through which only the mountain-peaks projected. I have already alluded to the work of the ice-plow in the excavation of lake-basins. I am now about to give to the glacier the credit of their preservation when formed.

Although it has been found that the glacier flows like the water of a river, only more slowly, the ice, except when wedged in between two walls, as the Mer de Glace, could not have been confined in narrow channels, and can not, therefore, have grooved out long, tortuous river-beds. The abrasion and drainage were indeed going on, but by a slow process, as compared to the work of the released and active waters.

When the ice-field began to disappear it gradually receded northward, first uncovering that part of the drift-region in which the lakes have been wholly drained. The southern half of the continent has had even larger rivers than now fed by the ice and snow of the gradually disappearing glacier. The length of time during which these rivers were doing their work of excavation, while the North was still

wearing its ice-crown, can be only approximately guessed. It was, however, a long time—a time compared with which the historic period dwindles into a few days. During these long ages, the outlets of the more southern lakes were being sunken by the slow disintegration of the rock; and, doubtless, while the ice-king still reigned in the North, these now "sweet vales of Avoca" had become dry land, and possibly the homes of men.

The physical geography of the country is a strong witness to the truth of this hypothesis. To the south of the drift, where the rivers have been flowing ever since the continent was above the sea, the lake-bowls have been drained to their bottoms; in the southern part of the drift they have been only partially drained, while to the north they are still filled with water. This exactly accords with the hypothesis.

It has been argued that the southern half of the continent has been longer from under the sea, and therefore that the rivers have had more time for deepening their channels. Exactly the converse is the truth. The Laurentian Hills are not only the oldest land on the continent, but, so far as now known, the oldest on the planet.

It may be admitted, without affecting this hypothesis, except it be to re-enforce it, that the great weight of the accumulated ice must have sunk the more northern region in some parts below the sea-level, and that in its gradual melting these rose again, preserving their equilibrium.

The gradual recession of the ice northward, and therefore the first uncovering of the southern half of the drift-region, must have taken place. That this recession was slow, and during a long period of years, must be true. That during this long time the rivers must have been deepening their channels and emptying the lake-basins, is so manifest as to need only to be stated. It we should term that portion of the drift-region, south of forty-one and a half degrees, *sub-glacial*, we shall find the southern part of it wholly drained, the middle and northern part of it only partially so, the lakes and lakelets increasing in number and magnitude on approaching its northern boundary.

But the "dry lakes" of the Pacific slope, what of them? Their margins are still intact. True; but it is because they *are* dry lakes that their margins have not been cut through and no rivers connect them with the sea. These lake-basins, too, were once filled with water; the rain-supply was not equal to the evaporation, and hence their gradual drying up.

Another cause for the destruction of lakes, too important to be left out of the account, is the continuous deposit of sediment on their bottoms. While their effluents are continuously sinking their surfaces, their affluents are no less industriously raising their bottoms by deposits from the land. The bottom of Lake Superior at its deepest place is about three hundred feet below the sea-level; it can not, therefore, be wholly drained by its outlet. But its supplying streams

are constantly sifting sediment on its bottom. The St. Louis River has a large delta, making access to Superior City so difficult as to require annual dredging. It has been estimated that the sediment yearly carried to the Gulf by the Mississippi is sufficient to raise a square mile two hundred and forty-one feet, or equaling a cubic mile in a little less than twenty-two years. Where the Rhône enters Lake Geneva, its water is loaded to its capacity with sediment; where it leaves the lake, it is crystal clear. This solid matter is being continuously deposited, raising the bottom, while the deepening channel is sinking the surface. In Indiana and Ohio are numerous shallow lake-basins, now dry land, their bottoms, level as a floor, with often several feet of rich alluvium, still bearing testimony to the agencies that have despoiled them of their waters. The celebrated Walnut Level of the former State is but an ancient lake-basin, and it is to this deposit of sediment that it owes its far-famed fertility. It is not improbable that by the time the Falls of Niagara shall have broken through the rim of Lake Superior, the sinking surface of the water may reach the rising bottom only a little above the ocean-level.

But why should the lakes begin to increase in size and frequency at about the forty-first parallel? The answer is to be found in the relative amount of snowfall during the glacial epoch. More snow falls at the south end of Hudson Bay than at Boothia Felix; more at Cape Farewell than at Cape Hatherton; more at twenty degrees south of the Arctic Circle than at any parallel north of it. The line of greatest snowfall, like the isothermal line, is irregularly extended, depending greatly on the wind-currents. The water of the southern winds condenses and falls as they reach the colder latitudes. Allowing the line of greatest snowfall to pass through Hudson Bay, it must have been far to the south of it during the ice period. At or near the forty-second parallel the glacier probably attained its greatest thickness. Here it intrenched itself to stay; and for a very long time the winter snows must have compensated for the summer thaws. While, therefore, that part of the drift-region lying farther to the south was uncovered, and the water-courses actively at work digging out their beds and draining the land, the whole country to the north was a field of ice. Simultaneously the ice and the line of greatest snowfall receded northward. As the day's greatest heat is not when the sun is on the meridian, but an hour or two later; as the summer's greatest heat is not when the sun is at its greatest altitude, but a month or two later; so it is probable that the highest average temperature has not yet been reached, and that the line of greatest snowfall is still receding toward the poles. This fact, if it be one, must presage for Arctic explorers wider and more open fields of work a thousand years hence than to-day.

The cause of the saltness of some American lakes is too patent to require many words of explanation. It is probable that, when the

continents were raised from the sea, the lake-basins had been already formed, and came up, therefore, brimful of water. In the northern and eastern part of the continent, where the supply from rain and snowfall exceeds the loss by evaporation, the salt, being continuously carried away through their outlets, has become so diluted as to be an imperceptible quantity. In arid regions, as the Pacific slope and the country about the Caspian, where the evaporation was in excess of the supply, the water-level of the lakes continuously sank until, on account of the diminished extent of surface, the equilibrium of loss and gain was attained. Hence the exceeding saltness of Great Salt Lake, the Dead Sea, etc. For a like reason the water of the Mediterranean contains more salt relatively than that of the ocean. Evaporation exceeding the supplies from the rivers and rainfall, it requires a constant current through the Strait of Gibraltar. The same is true of the Red Sea, causing a like current through the Strait of Bab-el-Mandeb. Other salt or brackish lakes probably owe their saltness to the supplies from the land. Water being the most general of all solvents, the rains gather up the chloride of sodium from the soils and the disintegrating rocks, and where the streams fall into lakes whose only outlet is evaporation, the land itself must be a constant source of saline supply, and their waters must become more and more salt, until their capacity as a solvent has been reached.

The Utah Basin must once have been filled to its brim with ocean-water. The outlet has been evaporation. The lake, receding to its present level, has left many evidences of its former extent.

To the drying up of salt lakes is probably due the presence of rock-salt, often found in great quantities in regions of little rainfall.

I come, lastly, to the *trend* of the North American lakes. A good map, and especially one on the Mercator projection, will show that lakes are not dotted promiscuously here and there, with no regard to system. They have with each other a trend of direction often as well defined as mountain-ranges, or the coast-lines of continents. As already shown, the great American depression bifurcates at about the fortieth parallel, and nearly at right angles, into northeastern and northwestern branches, whose lines of direction lie respectively in approximate parallelism with the far-off Appalachian and Rocky Mountain ranges, and with the still farther-off Atlantic and Pacific shore-lines.

Geologists, and especially physical geographers, have noted the fact that the mountain-ranges, the shore-lines of continents, and the islands with each other, have lines of trend mostly northeastward or northwestward. The lakes of North America have similar trends of direction, and therefore form an integral part of the great system upon which the planet itself is built. This is as should be expected. That the line of greatest depression should have an approximate parallelism with the adjacent greatest upheaval is but a physical necessity.

Many thousands—perhaps millions—of years before man was on the earth, the Laurentian Hills were raised above the dark waters, their origin dating back to the very dawn of life on the planet. Both the primordial continent and the primordial life were the prophets—this of the higher orders of organism, and that of the continents and islands yet to be. This original continent has held its own. It took the initial in the building up of North America. Its two lines of direction had the form of a right angle, one projecting northeastward and the other northwestward.

This is the normal plan. It is the structural arrangement, not of this continent only, but of all continents; and the lake-depressions, conforming to the general system, are an additional witness to the common underlying laws and forces of which the earth itself is a grand phenomenon.

LAWSUIT OR LEGACY.

By H. H. GARDENER.

WITHIN the past twenty years the business of life-insurance has grown with such wonderful rapidity, and changed so radically in its methods and contracts, that it is to-day as unlike its old self as the railway-car is unlike the stage-coach.

The old life-insurance contract undertook to define burglary, riot, and rebellion, and the companies held themselves free from obligations deliberately assumed, if the other party to the contract did not conform to the rules of conduct laid down under their definition and requirements. Nowhere else in the history of large business organizations has the debtor regulated his obligation by the morals of his creditor and liquidated his debt by acknowledging its existence, and then simply charging moral obliquity on the part of said creditor as the reason for not paying it.

If A owes B fifty dollars, and B is known to be a thief or a murderer, it does not liquidate A's debt to simply show that fact. But life-insurance companies have held, and some of them still claim, the right to so indemnify creditors, and, strange to say, they have been able to conduct business on that basis. They have even gone further, and said that a debt to B's heirs is forfeited in like manner—thus making the destruction of a man's reputation after his death of pecuniary advantage to the company. They have been enabled to do this because many men do not read the insurance contract which they sign, and hence have no idea of its complicated and, in many cases, unfair nature. If men insisted upon understanding the contract before they sign it, as they do in other business, the more unfair features would necessarily disappear from all insurance contracts.

If I deposit a thousand dollars in a bank, it is my money—I can

withdraw it when I please, subject, of course, to business rules, which have nothing to do with my standing as a citizen. The bank has nothing to say in regard to my loyalty or my honesty in other affairs. My money can not revert to the bank on outside ethical or moral grounds. But in life-insurance—a business in which more money is invested than in banking—the opposite rule has been, and to some extent still is, in operation.

There were a few companies, it is true, which rarely took advantage of their reserved right to mulct a family of money actually received, upon the plea of outside ethical delinquencies of the dead—which had nothing to do with his length of life—and there are companies, at the present time, which have voluntarily eliminated the greater part of these oppressive regulations and reserved rights from their forms of contract. But in many of the companies they still remain in full force, and in almost all there are improvements of a most important nature needed even yet.

In other words, while one or two companies have made their contracts, in large part, what contracts purport to be, a guarantee of good faith—that, if so much money is paid to them during a stated interval, they will return to the party insured, or to his heirs, a stated sum at a given time—there are still many which have not so improved their contracts, and are doing business in the old way, depending for success on the ignorance of their applicants in regard to the unfair conditions of the contracts which they sign. A few have left out most of the thousand and one ifs and ands and provideds of the old *régime*, and have at last undertaken to conduct this important and rapidly-growing business on strictly business principles, and the results have abundantly attested the wisdom of the new departure and indicate the advisability of still more liberal measures. A man may now, if he is careful and wise in his choice of a company, insure his life, or, if insured, he may have the temerity to die, without a fairly-grounded expectation of leaving his family a lawsuit for a legacy. He may also be reasonably sure that he is not placing his own reputation (after he is unable to defend it) at the mercy of a powerful corporation intent upon saving its funds from the inroads of a just debt. And I question if it is too much to say that, given enough money, a strong motive, and a powerful corporation, on the one hand, and only a sorrowing family upon the other, and no man ever lived or died whose reputation could not be blackened beyond repair, after he was himself unable to explain or refute seeming irregularities of conduct or dishonesty of motive. No man's character is invulnerable, and no man's reputation can afford the strain or test of such a contest. Millions of dollars have been withheld from rightful heirs by threats of an exposure—the more vague the more frightful—of the unsuspected crimes or misdeeds of the beloved dead.

Thousands of cases never known to the public have been "com-

promised," and hundreds of heart-aches and unjust suspicions and fears about the dead, which can never be corrected, are aroused in sorrowing but loving breasts by this method of doing "business." It is, of course, of the utmost importance that every precaution be taken by life-insurance companies to protect the funds held by them, in trust for others, against fraud and trickery. But with the agent, the examining physician, the medical directors, and the inspectors all employed by, and answerable to, the company represented, if fraud is committed in getting into the company, one or all of these paid officers must almost, of necessity, be party to that fraud. With all these safeguards in the hands of the company, if a man is accepted as a "good risk," if he pays his premiums, surely his family has the right to expect a legacy and not a lawsuit, nor a "compromise" which *must* cast reproach on the dead.

If it were not for the enormous value and benefits of this method of making provision for his family, surely no man in his senses would ever have risked—would not risk to-day—signing a contract which gives the other interested party not only an absolute fixed sum of his money, year by year, but also reserves to itself the right to investigate and construe his actions and motives after he is unable to contest its verdict.

And not only this, but upon the finding of some slight, wholly immaterial flaw in his statements (which it failed to find when he was in the hands of its agents and officers), in some companies he not only forfeits the right of his heirs to their purchased inheritance, but the company retains his money which he has paid in besides! This is surely a dangerous contract for any man to sign. It is placing a temptation and a power in the hands of a corporation that it has never yet been in the nature of corporations not to abuse.

"If any statement in this application is in any respect untrue, it voids the policy, and all payments which shall have been made revert to the company," gives a wide field and doubtful motive of action when it is remembered that many of the questions are of such a nature that not one man in a thousand could be absolutely sure that he knew the correct reply.

"At what age did your grandparents die?" All four of them. How many men are sure that they can answer that question correctly? "Of what did each one die?" You do not know. You have a general idea. You express it. You pay your premiums ten years. You die (one doctor says of consumption—another says of blood-poison); the company finds some old person who says your grandmother on your father's side died of the same thing, and there is a rumor that a long-forgotten (or never-known) country cousin also had it.

The company sends a representative to the widow. He assures her (and by the very terms of the contract, signed by the dead husband, he is right and she is helpless) that they can refuse to pay a

cent; that her husband got his policy by fraud—although no indication of his physical disorder appeared to any of the numerous officers employed by the company for its own protection, when he made his application, and by general reports he was (and believed himself to be) a sound man.

He assures her that they want to be generous rather than just, and if she will sign a release, or "compromise," she will be given a small part of the sum named in the policy. He makes her feel the necessity of keeping this bargain a secret, lest other policy-holders object to the company paying anything on the life of one who "attempted a fraud" upon them! He impresses upon her that in case of contest she could get absolutely nothing; that she is poor, and the company is rich and strong; and if he fails to arouse her gratitude for his generosity in offering to pay her anything whatever, he usually succeeds in intimidating her in her poverty and distress. A sparrow in the hand is worth more than an eagle on Mount Washington to a widow with a hungry family, especially if the eagle has successfully maimed his pursuer in the beginning of the flight.

The company knows this. The widow knows it. The conclusion is therefore certain before the premises are stated, and the "compromise" is made or the claim quietly dropped. It is easy to say that a man died of some bad habit unknown to his family, and his family would rather forego their claim than drag into light, or into disgrace, the memory of the loved dead. All this is well understood by those on the "inside," and by thousands of sad hearts that dare not speak. Is there no remedy for all this? Is there no way that a useful and powerful business can be rid of features which make it both dangerous and ghoulish?

The recent steps taken by the best companies are undoubtedly in the right direction, as those still using the old forms of contract will sooner or later learn. But there is room yet for improvement even in the best forms written to-day. The fairest insurance contract written still has room for improvement.

Is there no way to protect these great corporations against the frauds of individuals, and at the same time protect the individual against the frauds of the corporations?

Must life-insurance contracts be absolutely one-sided, and that be the side of the strong against the weak; the guarded against the unguarded; the living against the dead? It seems to me that this is wholly unnecessary. A life-insurance company which has the agents, the doctors, the medical directors, and inspectors all on its side can well afford to offer a fair field—a plain, fair contract—to its patrons, and then pay its debts like any other debtor when its obligation falls due. If it can not find out within a year (with all the machinery in its own hands), and while the man is alive, that he is a bad risk, it is too late to make the discovery after he is dead. If the indications are

sufficiently in his favor for them to accept his money from year to year while he lives, they are sufficiently favorable to him for his family to receive the company's money when he has died.

Life-insurance is too valuable and too necessary a means of provision for the family for it to be overlaid with abuses that make many men hesitate to avail themselves of its benefits; and which put a power for evil into strong hands, and make temptation to do wrong inevitable and constant.

It is said by some, whose attention has been called to this important subject, that the form of contract does not so much matter, since almost any court or jury will decide a suit against the company, and in favor of the family, in any event. This is taking it for granted that the heirs are in position, and are willing, to bring suit, and risk the reputation of the dead as well as the financial drain. But, as a matter of fact, this is not true—nor is it desirable that it should be. The rights of these corporations should be as jealously guarded by our courts as the rights of the individual; and perverted justice is a dangerous tool to handle. The man who signs an oppressive contract depending upon a court to nullify it after he is dead, is clinging to a rope of sand. The letter of the bond is what the court is bound to enforce, and every man should be sure that he signs only such as shall deal fairly with his heirs *on that basis.*

The following extract is from the decision of the Court of Appeals in the famous Dwight case, which is so recently decided as to most forcibly illustrate this point:

"If an insurance policy in plain and unambiguous language makes the observance of an apparently *immaterial* requirement the condition of a valid contract, *neither courts nor juries have the right to disregard it* or to construct, by implication or otherwise, a new contract in the place of that deliberately made by the parties. . . . Such contracts are open to construction, . . . but are subject to it only when, upon the face of the instrument, it appears that *its meaning is doubtful* or its *language ambiguous* or *uncertain.* . . .

"An elementary writer says: 'Indeed, the very idea and purpose of construction imply a previous uncertainty as to the meaning of a contract, for when this is clear and unambiguous there is no room for construction and nothing for construction to do.'"

For this reason the Court of Appeals cited as the ground, and the *only* ground, for its decision against the widow, the following clause from the policy of the contesting company:

"This policy is issued, and the same is accepted by the said assured, upon the following express conditions and agreements: That the same shall cease and *be null and void* and of no effect . . . *if the representations* made in the application for this policy, upon the faith of which this contract is made, shall be found in *any respect* untrue."

Colonel Dwight was in the habit of making large business vent-

ures. Several times, when he had done so, he had taken heavy amounts of life-insurance, so that in case of the failure of his undertakings, and his own death before he could regain his financial feet, his family would not suffer. On previous occasions he had dropped the greater part of his insurance as soon as his business ventures had terminated successfully. This is not an uncommon thing for rich or speculative men to do.

In 1878 Colonel Dwight died, with an insurance on his life of about $265,000, some of which he had carried for years; but a large part of it had been recently taken for the reasons above stated, and as he had done before under similar circumstances. Fifty thousand of this sum was in old and new policies against one company.

This company paid at once, thus giving the widow means to fight for her claims against the other companies. In a short time one of the other companies, against which she had a small claim of $5,000, also paid. The other *nineteen* companies contested. The widow employed Senator Conkling, and the fight has been the hardest, the bitterest, and the most ghoulish insurance contest ever had in this country; and finally the companies have won in the Court of Appeals on a purely technical point, after having dug Colonel Dwight's body up several times, in the effort to prove that he was poisoned, that he hung himself, and that he was not dead at all! They failed utterly to prove any *material* cause of contest; but they finally won on the ground that, in answering a question in the application for insurance, Colonel Dwight did not state that he had ever engaged in the liquor business, whereas it had been known that he had owned a hotel where liquor was sold.

Now, when it is remembered that at one time these companies tried to prove that Colonel Dwight had committed suicide, but that they never had any grounds upon which to claim that he had died of intemperance, the purely technical grounds for the decision of the Court of Appeals is apparent. Ninety-nine policies out of a hundred could be contested on such ground as that; and so long as insurance contracts retain these unreasonable and oppressive features, no man can be sure that he is not leaving a lawsuit and bitter sorrow to his family, and worst of all a blasted reputation for himself, when he applies for insurance under such a form.

An officer of one of the companies was heard to boast of the fact, but a few days ago, that his company had spent nearly *ten times* the amount of the claim against it in this Dwight contest! This is economy indeed! Whose money was thus spent? The policy-holders'. For what? To defeat one of the policy-holders in a contest for a claim no doubt as honest as any one of the others will present in his turn.

But suppose that this was not an honest claim; suppose that Colonel Dwight was not a "good risk," is it not a rather suggestive indi-

cation of the value of the medical examinations by the expert medical examiners and directors of twenty-one life-insurance companies? A risk good enough to "pass" some forty-five doctors employed by, and for the protection of, the companies is, on the face of it, a good enough risk to pay. If this is not so, then the companies, and not the public, should be made to bear the responsibility of the incompetency of their own officers.

But for the reputation of these medical men, it is a fortunate fact that the contest did not prove Colonel Dwight to be an unsafe risk. After his body was dug up several times, and a number of autopsies held, and most of him analyzed, they succeeded in proving that he owned a hotel where liquor was sold!

But under these forms of contract, the companies undoubtedly had a legal right to refuse payment upon even so absurdly technical a misstatement of "occupation." It was claimed that his hotel was a side issue; that he did not think of himself as in that business, and that his failure to say, because of it, that he was "in any way connected with the manufacture or sale of spirituous liquors," was a natural one under the circumstances. How many men give, in answering the question as to occupation in their applications for insurance, *all* of the numerous "plants" in which they have an interest of a financial nature, more or less important? One man says he is a book-keeper, but he may possibly, also, own stock in a mine. His claim could be contested on that ground. Suppose that he really thought nothing of his mining-stock when he made his application and signed his contract? Suppose that in a short time he was called to see the mine, went into it, and died of the results of that trip? His policy would not, if it contained the usual conditions, be worth, in a legal fight, the paper it was written on.

That companies often waive their reserved right to contest on such grounds, is used as an argument to prove the innocent nature of these forfeiture clauses and other oppressive conditions. But so long as they hold the legal power to do so, the temptation to contest will be too great for flesh and blood, not to say for corporations, to bear without yielding sometimes. The "Get thee behind me, Satan," of a fair, plain contract will be the best safeguard for the heirs in the matter of money, and for the companies in the matter of morals; while the "economy for the sake of surviving policy-holders" might be directed, as there is surely room for believing that it needs to be, into other and more legitimate channels. Economizing on debts to dead policy-holders is not a very good recommendation to living ones, for the companies which thus lock the wrong stable-door.

The new move toward furnishing fair contracts is in the right direction, and it now rests with insurers—the public—to see that it does not stop short of fulfilling the promise of still better things in the future.

AMONG THE "THOUSAND ISLANDS."

By GRANT ALLEN.

"THE humming-bird has now laid its eggs in the nest by the veranda," our friend wrote us from Gananoque; "come soon if you want to see them. And Miss Sinclair has tamed a chipmunk, which eats almost from her hand, by the big tree. I'm sure your boy would like to have a peep at him. Also, the Indian-pipe plant is beginning to flower in the wood behind the house. It doesn't last long; you must make haste, or you will be too late for it."

We knew the hospitable chalet at Gananoque of old; and even if our friend's society had not been enough of itself to entice us (which it amply was), the added delights of a humming-bird's nest, a tame chipmunk, and the Indian-pipe plant in full flower might surely have sufficed to move the heart of the stoniest of parents. I don't go in, myself, for being what you may call stony; on the contrary, where the junior branches are concerned, I acknowledge myself but as clay in the hands of the potter; so the very next day saw us safely packed on board the Princess Louise river-steamer, three precious souls, and all agog to dash through thick and thin on the heaving bosom of the broad St. Lawrence.

And the broad St. Lawrence *did* heave that July evening, no mistake about it. A fresh west wind was blowing over the lake, and the spray was dashing up with sea-like violence as we steamed away from the wooden wharves of Kingston, heading down-stream for the Thousand Islands. Lake Ontario, when it chooses, can get up a very decent storm indeed; quite as fine a storm as any to be seen upon the German Ocean, with huge four-masters from Chicago stranding helplessly on the reefs and spits; and even the river can run seas-high in its broader reaches among the wide expansion known as the Lake of the Thousand Islands. Now, Gananoque is the petty metropolis of the Thousand Island district on the Canadian side, as Alexandria Bay and Clayton are on the American shore; and the Princess Louise is the little steamer which plies daily between Kingston and Gananoque during the summer season, when the ice is up and navigation is open. But I have always found European ideas as to the geography of Canada so very vague that I shall make no apology for beginning my story with some slight account of the Thousand Islands and their immediate surroundings.

Just at the point where the huge St. Lawrence emerges lazily from Lake Ontario—or where Lake Ontario narrows into the St. Lawrence, whichever you will—the bed of the river crosses a transverse range of low granite hills, whose bare summits have been ground into dome-shaped bosses (or *roches moutonnées*, as they say in Switzerland) by

the enormous ice-sheets of the Glacial epoch. The granite of the chain is very hard and pure ; it is quarried in large masses, indeed, for monumental and building purposes, among these very islands ; and so the great river, unable to cut itself as profound a channel as it might otherwise have done in a more yielding rock, has spread itself out in wide pools over a broad and shallow bed, only deep enough for large navigation by river-steamers in two or three well-recognized currents. The main line of the Grand Trunk Railway, in fact, between Kingston and Montreal, traverses this same low, granite range, and exhibits very clearly the conditions precedent for the production of so strange and beautiful a phenomenon as the Thousand Islands. The range consists of numerous crouching, ice-worn mounds or hillocks, shaped exactly like a pig's back—or, to be more respectful, let us say an elephant's, or a basking whale's—while in between them lie deep grooves, or valleys, equally ice-worn, all running parallel and scratched alike, as is necessarily the case with the grooves due to the downward movement of a single great glacier or ice-sheet. Now, the average width of the St. Lawrence under normal circumstances, when it isn't trying, Yankee fashion, to do a big thing, is about a mile or a mile and a half. But when it encounters this belt of ancient ice-worn gneiss, with its accompanying dales, it spreads itself out into a sort of encumbered lake some ten or fifteen miles wide, filling up the grooves and interstices between the rounded humps, but leaving the higher mounds or hillocks themselves as tiny islands intersected by endless miniature channels. The name Thousand Islands is by no means due to characteristic American exaggeration : the official survey, made for the Treaty of Ghent gives the number as sixteen hundred and ninety-two, and they extend for forty miles down the river from Kingston to Brockville, in a perpetual succession of beautiful pictures.

If the islands and islets still remained merely in their original condition, as rounded, dome-shaped knolls, clad with pine and maple and Virginia-creeper, rising hump-like in slow slopes from the water's edge, they would still be extremely romantic and picturesque. But they are far more than this. The ceaseless action of the river at their sides, aided by the disintegrating frosts of winter, and the pressure of the ice-packs when the lake "breaks up" in early spring (exactly as if it were an academy for young gentlemen in the Easter holidays), has cut many of their edges into steep little cliffs, fantastically weathered, as granite almost always weathers, into beautiful broken crags and pinnacles. Thus the cliffs often spring sheer from the surface of the water, worn by rain and frost into quaint, jutting shapes, and with rare ferns and flowers and creepers hanging out here and there from their creviced nooks. The summits remain for the most part smooth and polished by the old ice-action ; and the contrast between their bald, round surfaces, almost gray with age and lichens, and the jagged and ruddy outline of the more recent fractures, makes an extremely bold

and effective element in the total picture. The islets are also of every imaginable shape, size, and grouping—some of them big enough to hold two or three farms, and others of them rising solitary from mid-stream, crowned by a single waving stem of Canadian cedar. Here is one, for example, a mere bare pinnacle of moldering rock; and here is another, a craggy little island, yet covered with endless variety of timber, whose drooping foliage hangs over the bank and reflects itself placidly in the silvery mirror below. Thus cluster after cluster passes before one's eyes, all fairy-like, green, and romantic, but all as infinitely varied in shape and contour as intricate intermixture of rock and vegetation, and land and water, can possibly make them.

I must give the reader due warning, however, that on this ground I am perhaps a trifle enthusiastic. To say the truth, if I may for once be frankly personal, I speak with the pardonable partiality of a native. I am, indeed, an aboriginal of this very district, born at Kingston, the threshold of the St. Lawrence, and "raised" (as we say beyond the Atlantic) on the biggest and longest of the Thousand Islands. Hence, something of the glamour of childhood surrounds the region still in my eyes: sweeter flowers blow there than anywhere else on this prosaic planet; bigger fish lurk among the crevices, bluer birds flit between the honeysuckles, and livelier squirrels gambol upon the hickory-trees, than in any other corner of this oblate spheroid. I see the orange lilies and the lady's-slippers still, by the reflected light of ten-year-old memories. So the cautious reader will perhaps do well to take a liberal discount of twenty per cent off all my adjectives, to submit my eulogistic verbs to a strict *ad-valorem* drawback, and to accept the remainder as probably representing an unprejudiced view of the situation. I am not, I will admit, a patriotic Canadian—in so small a community patriotism runs perilously near to provincialism—but I must allow that a warm corner still exists in my heart for the rocks and reaches of the Thousand Islands.

The Princess Louise steams down the Canadian Channel—one of the two chief navigable currents—past Wolfe Island, where I spent a rustic boyhood with the raccoons and the sunfish, and on through endless groups of other wooded islets, with cedars sweeping low to the water's edge, till, after a couple of hours aboard, two white wooden lighthouses, guarding the entrance to the little harbor, announce our approach to Gananoque. A "creek," or minor river (pronounce it "crick" if you wish to be thoroughly transatlantic), here joins issue with the great St. Lawrence, and of course on its way indulges in some local waterfalls, once pretty, but now made to do duty, alas! with American utilitarianism, in turning the saw-mills which are the *raison d'être* of the flourishing small village. I will not describe Gananoque itself—Canadian villages are best left to the imagination of the charitable reader; I will only say that its natural situation is absolutely charming, and its bay and outlook "as beautiful as they make them."

The Princess Louise drew up at the rough log wharf, choked with immense piles of white-pine planks—"lumber," as the American language gracefully phrases it; and even as we reached the tiny quay we saw our hostess in her row-boat, already pulling round a granite bluff from her retreat to meet us. By private arrangement with the captain, indeed—so sweetly simple and domestic is life in these new countries—the engineer "scooted," or blew, his whistle three times as he passed the lighthouse whenever he had visitors on board for our friends' chalet. The moment the "scoot" is heard on the cliff, the chalet folks put out their boat at once, and row round to the landing-place to take up their visitors without delay on arrival.

It is one of the charms of our vast England that here a man is lost in the crowd. The individual withers (much to the advantage of his own comfort), and the world is more and more. You can walk along the streets of London any day with the serene consciousness that nobody knows you or cares a pin about you, that to all the passers-by you are merely another nameless passer-by, that your personality is wholly merged in the recognition of your abstract existence as a single unit of assorted humanity. That, I say, gives a man a delightful sense of breadth and freedom. You feel yourself planted, as the inimitable Prince Florestan aptly phrases it, "at the strategic center of the universe, for so I may be allowed to style Rupert Street," with your individuality wholly obliterated, in the general consciousness of our common human citizenship. But once in a while, as an incident of a summer holiday, it is not wholly unpleasant, by way of contrast, to find one's self for a time in such a narrower world of mutual recognition, where the purser knows immediately you are going to stop with your friends in their summer quarters, and gives notice to the engineer to blow the whistle thrice accordingly as you pass the chalet where they presently abide. A certain patriarchal colonial note in it all attracts one's not unfavorable attention. If you were a duke in England, the constituted authorities would refuse to whistle for you; it is agreeable now and again to feel yourself a duke, and to be recognized and whistled for with more than ducal consideration. I much prefer it to the South Coast Railway style, where my urbane inquiry, "Is this the train for Brighton, please?" meets with the crushing response from guard or porter, "All right! third class forward!"

We disembarked from the Princess Louise, and took our seats in the chalet row-boat. Our hostess pulled; politeness compelled me to offer myself as an unworthy substitute, but, when she firmly declined to surrender the sculls, I felt a secret twinge of satisfaction, for though it's one thing to pilot a dingey from Oxford to Sandford Lasher, it's quite another thing to pull a heavy hen-coop against the big waves of the full St. Lawrence on a windy evening. Canadian ladies think nothing of a mile or two of rowing, or of a stiff breeze; and modesty recognized the palpable fact that the sculls were in far more compe-

tent hands. Practice makes perfect, however; and a few weeks in Canada soon brought back to me the old knack of rowing with tholepins instead of rowlocks, though to the last the instinctive tendency to drop the wrist in the vain effort to feather—feathering, of course, is impossible with the pins—persisted always, much to my discomfiture.

The chalet, whither we were bound, stands a little removed from Gananoque village, in wild grounds all of its own, raised high among the woods, on top of a sheer cliff, beneath whose frowning crags we rowed into a little bay or haven, protected by a bold granite headland from the sea, that rolled high upon the open river. There we pulled up beside the floating wooden landing-stage, and disembarked on the grounds of Mossbank. (The real name was not Mossbank, but something very much prettier and more appropriate, only my friend's solemn adjurations have bound me down by inviolable promise not to reveal either its local habitation or its name too openly to the profane vulgar, or even, which is quite another matter, to the candid reader of this present magazine.) I forget how many steps, partly wooden, and partly cut into the solid granite of the headland, led up the face of the perpendicular cliff from the water's edge to the chalet platform. I was told at the time—something like one hundred and ninety, I fancy; but the beautiful picture of that calm bay, and the hanging woods, and the maiden-hair fern springing in wild luxuriance from the clefts of the rock, and the bearberry clambering over the ice-worn bosses, and the wild sarsaparilla raising its green berries on its tall, bare stalk, and all the thousand and one exquisite details of frond and foliage, and fruit and flower, distracted my attention from arithmetical facts, gradational or otherwise, and left me only eyes and mind for the beautiful scene that unrolled itself slowly, step by step, before me.

At the summit, on a rounded, rocky plateau of bare granite, overgrown in places by clambering shrubs and trailing Western creepers, the chalet itself fronted the Sunset Islands, and looked down from its aërial perch upon the intricate maze of russet land and purple water. To the right lay the lighthouses and the islands in their neighborhood; in front, one islet behind another stood massed in view, backed up by the low hills of the New York shore; to the left, the high cliff closed in the sight, with a single rocky island rising full in prospect, and the river stretching illimitably onward, broken by endless tiny archipelagoes, in the direction of the Cornwall Rapids. For the chalet itself, how shall I fitly describe it? A more charming summer-house was never devised for human habitation. Being meant for midsummer use alone, warmth and snugness were left wholly out of consideration; all the stress was laid upon coolness and breeziness in the sweltering heat of Canadian August. Inside and out, the chalet was scrupulously of wood, wooden; it was built of the native white pine, polished both sides, one thickness of boards only, and all the constructional details within and without were plainly visible to the naked eye in a way that

would have delighted the honest souls of Scott and Fergusson. The inner walls showed the polished framework (like a good church-roof) that supported the single layer of planks, unpapered, and otherwise undisfigured; the polished beams and joists overhead bore the weight of the boards that formed at once the ceiling of the drawing-room and the floor of the neat little bedrooms up-stairs. Thus every room had six sides of polished light-brown pine-wood—floor, ceiling, and four walls. A few delicate Oriental rugs and native fur-skins lay daintily upon the waxed floor; etchings and sketches hung upon the walls; light and graceful summer-like furniture filled up the rooms; but otherwise all was the clean wooden framework, and delightfully cool and appropriate it looked. Further to carry out the summer effect of the whole, the three reception-rooms on the ground-floor, instead of being jealously partitioned off from one another with the stereotyped formality of urban life, were thrown into one by broad archways, where folding-doors might have been, but were not, so giving an air of roominess and freedom to drawing-room, dining-room, and library alike, which was especially grateful in hot Canadian noontides. With doors and windows flung wide open, and roses and honeysuckles peeping in from the richly festooned pillars of the veranda, can one imagine a more delightful spot in which to spend a cloudless summer?

For, to complete the charm, a veranda ran round the house below, with broad shade and comfortable rocking-chairs, and creepers clambered up the posts around, making, as it were, a rustic frame for the exquisite picture of river and islands that lay beyond. Up-stairs, each bedroom opens out onto a continuous balcony, formed by the roof of the veranda, and running round the whole chalet, Swiss or Norwegian fashion, with a wood-work balustrade, overgrown with lithe sprays of native climbers. The view from the balcony was even finer than that from the platform of rock on which the house stood; it opened up yet wider vistas of the river, and gave a broader prospect over the blue hills of the dim American shore beyond.

I have been thus particular in describing the house at Mossbank, because it may be taken as a fair sample of the delicious little summer cottages in which Americans and Canadians lounge away the sultry months of the transatlantic season. Our hostess, indeed, who combines the artist's eye with the poet's, had been peculiarly happy in her choice of a site: Mossbank stood on, by far, the prettiest point we saw anywhere among those sixteen hundred and ninety-two fairy-like islands; but almost all the cottages we visited were picturesque and appropriate to their use and situation, though none other, perhaps, was quite so graceful in its design, or so dainty in its appointments, as the one in which we were fortunate enough to fix our headquarters. Dozens of such cottages now stud the prettiest parts of the various channels, and it is locally fashionable to run them down as disfiguring and modernizing a beautiful piece of rustic wild scenery. For my own

part, though I have known the islands intimately from childhood upward, and can remember them when their only inhabitants were minks and musquash, and their staple products blueberries and wild-flowers, I do not think the quaint little cottages and the wooden bungalows are anything other (in most cases) than improvements to the district. And I am rather a Puritan, too, in this matter of wildness. I hate the intrusive foot of civilization. But civilization, as it shows itself among the Thousand Islands, is not intrusive; it rather heightens than detracts from the total impression. By themselves, the islands tend toward sameness; a graceful chalet, a light wooden toy farm-house, a white, gleaming lighthouse, judiciously planted on a jutting height, and well embowered in spruce-fir and maples, give individuality and distinctiveness to the picture, and supply the landscape with what it otherwise sadly lacks—*points de repère*—in the tangled maze of wood and water. Every view is all the better for an occasional landmark; the wildest nature is somewhat improved by a stray token of man's occupancy and the possibility of intercourse with the mass of humanity.

For, except the cottages, the islands have been mostly left by the common good taste of their owners and occupiers in their native wildness of rock and foliage. No foolish attempts have anywhere been made at the outrage known as landscape-gardening: the granite crags and the festoons of wild-vine or Virginia-creeper have been wisely retained in God's own handywork. The grounds of Mossbank, in particular, were especially charming. In front of the house the bare platform of rounded granite gave place here and there to irregular patches of shallow greensward, in which a few bright flowers grew as if naturally, while native shrubs found a firm foothold in the deep dikes weathered at joints in the solid rock. All round stretched rich Canadian woodland, carpeted with undergrowth of blueberry and poison-ivy. From the edge of the cliff, which toppled over sheer I know not how many hundred feet into the river below, one looked down into pellucid depths of limpid water, where even from so great a height the bass and pickerel might be distinctly descried waving their restless fins against the black background of rock at the bottom. Everywhere around lay delicious spots where one might fling one's self at one's ease on the smooth gneiss, almost as polished as if by a lapidary's wheel, and pick sweet flowers from the crannies between—flowers of that beautiful exotic Canadian woodland type, so different from our weedy European pattern.

On one side, a little back of the chalet (which could practically be approached by water only), lay a deep ravine whose bottom was filled with rich peat-mold, the home of innumerable exquisite ferns, a paradise for the botanist, pregnant with hints as to Nature's ways among the flowers and insects. I could linger here for hours discoursing of the strange and lovely plants that grew profusely in that shaded dell,

only I'm afraid the courtesy of the proverbially courteous reader would scarcely survive so severe a strain upon its well-known indulgence. I will hurry on to the boat-house, therefore, which lay at the riverward mouth of the deep ravine, and formed, so to speak, the *embarcadère* for everywhere; for the river is, of course, the true highway of the Thousand Islands, and the boat is the gig by which one effects communication with the outer world, and pays one's visits to friends and neighbors.

Indeed, among the islands one lives upon the water. By a certain tacit understanding between the islanders, every resident has a recognized right to explore every other resident's petty domain. No obtrusive notice-boards flaunt before the innocent face of heaven the antisocial and wholly uncalled-for information that trespassers will be prosecuted with the utmost rigor of the law. On the contrary, the usual formula painted on the neat little placard beside the tiny landing-stages assumes the optative rather than the imperative mood: "Parties landing on this island are requested to kindly abstain from damaging the ferns and flowers." The fact is, all the islanders are there as summer visitors only; each possesses but a tiny realm of his own, often beautifully varied, but always readily exhausted of its native interest; and the whole charm of the spot would evaporate entirely if proprietors insisted with ingrained British churlishness upon their legal right to shut themselves in from landless humanity with the effectual protest of a high brick wall. Accordingly, everybody always lands freely, no man hindering, upon everybody else's private island; and the day is mostly passed in wandering (afloat) in a delicious, aimless, listless fashion down tiny channels between islet and islet, stopping here to pick a rare wild-flower from a cliff on the side, and halting there to explore and climb some jutting rock whose peak promises a wider view over all the surrounding little archipelagoes.

Many of the islands are still uninhabited, and these are the best of all for botanizing purposes. It is there that you may find the Indian-pipe plant, known also by the still stranger and truer name of corpse-weed; a beautiful drooping white flower, as pale and soft in its material as a fungus, of which our hostess said to us prettily: "When I first saw it I was half afraid to touch the uncanny thing. I thought I had found the ghost of a flower." It is, in fact, a lily-like flowering-plant; a heath by family, which had adopted the habits and mode of life of a fungus, living entirely like a parasite on the decaying foliage beneath the forest-trees, and has therefore lost its green leaves and assimilated in all unessential particulars to the other fungi whose ways it mimics. But I have promised not to be botanical here, so I will refrain from cataloguing all the other wonderful and lovely things to be found on these little island Edens. I will only say in passing that the scarlet columbines, the pinky-white water-lilies, the crimson baneberries, and the snowy anemones combined with the creepers, the ferns, and the

club-mosses, to make as beautiful and varied a carpet as any I have ever beheld anywhere.

Others of the islands have chalets or cottages perched upon their tops, and to these we often rowed through devious channels, trailing a spoon, for black bass, behind, and catching for the most part nothing more valuable than water-lily leaves and Canadian river-weeds. Sometimes a cottage will occupy a single rocky islet, and its grounds will extend to two or three adjacent ones, connected with the home island by rustic bridges, just arched sufficiently to allow a boat to pass easily beneath them. On the American side, the picturesqueness of the scene is occasionally marred by too profuse a display of the national bunting: Canadian loyalty, though sometimes also a trifle obtrusive, seldom indulges in so lavish an ostentation of the British ensign. There are islands, too, where an ill-advised proprietor has had the bad taste to paint up the name of his domain on a big board—"Idlewild," or "Sunnyside," or "River Home"—as though the rock were a railway-station, and the porter were at hand to shout out in incomprehensible syllables, "Change here for Montreal and Chicago."

Few modes of life could be more graceful or humanizing than summer life in these delicious archipelagoes. Here and there, to be sure, as at Thousand Island Park, a whole big island has been bought up by speculators (oddly mixed in the making with camp-meetings and other revivalist religious gatherings), and laid out as a sort of exclusive Bedford Park, where none but approved members of a particular sect may take a cottage. One such little summer village is exclusively Methodist, while another is wholly given over to serious Congregationalism. But in most parts of the group (and it must be remembered that the islands cover, roughly speaking, an area of forty miles by ten or fifteen) each house occupies a little insular kingdom of its own, where the boys and girls can swim, and fish, and play, and flirt, unmolested; where the seniors can lie in hammocks under the trees, and ruminate on politics, philosophy, and the tender affections; where callers can be espied from afar as they approach the shore; and where hospitality on a simple scale is as universal as it is unexacting. Note, also, that big black bass and muskallonge still lurk among the cracks and crannies of the submerged granite, and that on many islands you can sit on the jutting end of a tiny promontory and drop your line for them, plump from the shore, into twenty feet of clear green water.

One last word to the British tourist who, stirred by my natural and indigenous enthusiasm, may perhaps contemplate some day visiting and exploring the Thousand Islands. Don't for a moment suppose that the islands can be adequately seen from the deck of one of the big lake-steamers that ply up and down between Montreal, Kingston, and Toronto. This is the stereotyped British-tourist way of seeing them, and nothing could be flatter or more disappointing. If you take them so, I do not doubt you will come away objurgating me by all your domes-

tic deities. The steamer sticks to one or other of the two main channels, which are wide and deep, and comparatively unencumbered by rocks or islands; it avoids the tiny minor reaches, rich in endless surprises and varying vistas which constitute the real charm and beauty of this fantastic, fairy-like region. No, no! to see the islands properly, you must live on one of them for several days at least, and row up and down among the lost side-channels and tangled back-waters, exploring the petty bays and inlets, and occasionally losing your way altogether among the endless intricacies of that maze of water. But if you can not afford the time to see them thus, you should at least spend a day or two at Clayton or Gananoque, and take the "round trip" on the little excursion-steamer, Island Wanderer, which threads its way in and out through the loveliest windings of the landlocked river.—*Longmans' Magazine.*

HUMAN BRAIN-WEIGHTS.

By JOSEPH SIMMS, M. D.

ALTHOUGH we may regard it as fully admitted that the external appearance of the skull is no certain indication of the mental caliber of the individual, still there are many who are inclined to measure mind in terms of matter, believing it to be somehow dependent on the material constitution of the brain. Texture, the relative proportions of white and gray matter, and especially weight, are regarded as important factors in the problem, and it is on this latter subject that I have compiled and would offer what, so far as I have been able to ascertain, are trustworthy data concerning the weight of this important organ. The average brain-weight appears to be higher in cold than in warm climates. The "Lancet" has recorded the observation that men with large heads endure cold better than those with small ones. The Lapps have the largest heads in Europe in proportion to their stature; Norwegians next; then come Swedes, Danes, Germans, French and Italians. The Arab head is smaller than any of these. In the Pacific Ocean, far to the north, a people called Chugatshes, with remarkably large heads, occupy the shores and islands of Prince William Sound.

The average size of brain differs also at different stages of life; so that two men, each examining several hundred brains in the same city, may not obtain exactly the same results; because the subjects of the one may be chiefly aged, and those of the other young, though mature. In this case the latter would show a much greater average weight than the former, because of the natural decrease of the brain with advancing years. The following acknowledged authorities have presented the facts as they found them, after weighing a large number of brains:

Dr. John Reid, of the Royal Infirmary, Edinburgh, states the aver-

age weight of the encephalon at the age of from five to seven to be forty-three ounces, ten drachms; from twenty to thirty, fifty ounces, nine and a half drachms. The female brain in the human species is generally lighter in mature years than the male by five ounces, or ten per cent, while her stature is only eight per cent less.

Dr. Peacock gives an average of one hundred and thirty-one male brains, between twenty-five and fifty-five years of age, as fifty ounces, three drachms. Dr. Austin Flint, of New York, estimates the male encephalon at 50·2 ounces. Dr. Thurman considers the average brain-weight of ordinary Europeans to be forty-nine ounces. This average may answer for Europe in general, but it would be too small for the colder regions, as shown by the averages of Dr. Reid and Dr. Peacock, taken in Edinburgh, as also it would be too little for New York, according to Dr. Flint.

In Italy, Greece, and Spain, the average is smaller than Dr. Thurman's, and in France, M. Bourgery finds the average weight of the male adult brain to be 46·6 ounces.

The average male brain-weights of different nations is given at—

50·3 oz. from 105 English and Scotch. (Peacock).
49·1 oz. from 18 Germans. (Wagner.)
48·7 oz. from 40 Germans. (Huschke.)
47·3 oz. from 50 Austrians. (Wiesbach.)
47·0 oz. from 28 French. (Parchappe.)
45·4 oz. from 8 African negroes. (Broca.)
43·6 oz. from 7 African negroes. (Various authors.)

We borrow the above table from Dr. Paul Topinard's "Anthropology," 1878, page 311.

To this we add the following average brain-weights, taken from the "Anthropological Review" of 1869, pages 190–192. If we compare the average weight of the African negro brains given in the above table with those of the full-blood negro brains taken from the one hundred and thirty-nine negroes raised in the United States of North America given below, it will be seen that the colder climate of the United States produces heavier brains in the negro than the warm climate of Africa:

139 negro brains in United States averaged	46·9 oz.	avoirdupois.
1 Guinea negro	44·4 oz.	"
Hindoos' mean brain-weight	44·2 oz.	"
3 Ashantees averaged	42·9 oz.	"
1 Fantee	41·6 oz.	"
2 Congo negroes averaged	39·7 oz.	"

Dr. A. Wiesbach, a famous investigator of brains in the Austrian Empire, states that the heaviest are found among the Czechs; those of the Roumani are somewhat lighter; the Magyars or Hungarians lighter still; yet their brains average eight grammes more than the Germans of this empire; while the Italians are the smallest of all, being about

25·21 grammes less than the Roumani. The South Slavonian brains are somewhat heavier than the Italian, but lighter than any of the other peoples. One third of the Austrian Empire is peopled by Germans, descended from the natives of Austria proper. The Magyars are Asiatics of the Mongolian race. The South Slavonians occupy the most southern part of the empire, along the low-lying lands of the Danube, which accounts for the small size of their brains; while the Italians are descended from the inhabitants of a still warmer region; all which goes to confirm the theory we have already announced, that the smallest brains belong to the warmest climates. "On comparing the peoples of the four families represented here," continues Dr. Wiesbach, "we find that the Slavonic family possess the largest encephalon, the Romanic the smallest; and that the intermediate Magyars possess a more weighty encephalon than the Germans, which are nearly equal to the Romanic stock."

In a recently-published work Professor Bischoff, an eminent anatomist at Munich, gives the average brain-weight of males as forty-eight ounces ("Nature," January 20, 1881) after weighing five hundred and fifty-nine subjects, the obvious reason for the discrepancy between him and the authors above mentioned being the fact that Munich, situated in the southern part of Germany, is warmer than either Edinburgh or New York.

Dr. Tiedemann, of Heidelberg, on the Alpine plateau of the Rhine in Germany, where it is far colder than Edinburgh in winter, gave the average male brain-weight, for the whole of life above puberty, as 53·25 ounces. Sir W. Hamilton, of Edinburgh, estimated the average adult brain, without distinction of health or disease, at 48·25 ounces, for the whole of life. In London, Dr. Sims found it 46·25 ounces. Luschka gives 50·2 ounces as the average weight of a man's brain; Krause makes it 55·4 ounces, according to an article in the "Morning Herald," Sydney, Australia.

The above averages differ, from several causes. Dr. Tiedemann's observations were limited to fifty-two subjects, and included both sexes, but excluded negroes and very aged persons. Sir W. Hamilton had sixty or seventy of both sexes; Dr. Sims, two hundred and twenty; and Dr. Clendinning still more than Dr. Sims, whose patients were largely among the aged, and those afflicted with long-standing disease. Dr. Clendinning, in the Croonian Lectures, gives the following brain-weights from male subjects, which show that the male encephalon loses more than an ounce every ten years after it is fully grown:

15 to 30 years	50·75 oz.
30 to 50 "	49·66 oz.
50 to 70 "	47·1 oz.
70 to 100 "	41·5 oz.

Several other eminent anatomists have made similar exhibits—brain-weight decreasing as the intellectual power increases. It is

logical, therefore, to conclude that no parallel exists between power of mind and weight of brain.

M. Nikiforoff, a Russian scientist, in an article in the "Novosti," on the weight of brains, expresses his conviction that the weight of the encephalon has no influence whatever on the mental faculties. But, indeed, any reflecting person who has studied the brain-weights of eminent men as compared with ordinary intelligences must arrive at the same conclusion—that a great mind may belong to a person who carries a very small, a medium-sized, or a very large brain, the size and weight neither adding to the mental power nor detracting from it, provided only that the encephalon is sufficient to give due support to the bodily life. And this leads us to note the relation of the size of the brain to the size of the body of which it forms a part.

The following table is taken from the second volume of the "Science and Practice of Medicine" (London, 1868). Its object is to show the weight of the brain relatively to the weight and height of the body at various ages and in both sexes:

AGE.	Sex.	Weight of body.		Height of body.	Weight of brain.
		Lbs.	oz.	Inches.	Ounces.
1–2...	Male.	14	6	28·5	33·25
	Female.	13	2	27·7	29·80
2–4...	Male.	20	0	31·6	38·71
	Female.	18	7	31·6	34·97
4–7...	Male.	25	8	37·5	40·23
	Female.	24	9	37·0	40·11
7–14...	Male.	42	6	47·0	45·96
	Female.	38	6	45·0	40·78
14–20...	Male.	68	0	60·5	48·54
	Female.	63	14	57·7	43·94
20–30...	Male.	92	14	66·75	47·90
	Female.	86	13	62·0	43·70
30–40...	Male.	98	3	66·5	48·20
	Female.	87	0	62·0	43·09
40–50...	Male.	102	0	66·8	47·75
	Female.	84	9	62·0	42·81
50–60...	Male.	102	0	66·0	47·44
	Female.	86	0	62·0	43·12
60–70...	Male.	103	13	65·7	46·40
	Female.	86	14	61·5	42·69
70–80...	Male.	106	13	65·7	45·50
	Female.	80	4	61·0	41·27
80–90...	Male.	99	0	66·7	45·34
	Female.	79	0	60·0	39·77

The above table, made by Dr. Boyd from sixteen hundred and seven post-mortem examinations of sane persons, shows that the human brain reaches its maximum of weight in proportion to the rest of the body between the ages of fourteen and twenty in both sexes; and then it continues to decrease through life. While intelligence is rapidly increasing from twenty to sixty years of age, the brain is diminishing. The time that a man knows most is from seventy to eighty; but then

his brain is smaller than when he was a boy between seven and fourteen, the age when he thought he knew the most.

Dr. Paul Broca gave the following table of average brain-weights:

From 1 to 10 years,	985·15 grammes	(34·7 oz.).
From 11 to 20 years,	1,465·27 "	(51·68 oz.).
From 21 to 30 years,	1,341·53 "	(47·67 oz.).
From 31 to 40 years,	1,410·36 "	(49·74 oz.).
From 41 to 50 years,	1,391·41 "	(49·07 oz.).
From 51 to 60 years,	1,341·19 "	(47·30 oz.).
61 and upward,	1,326·21 "	(46·77 oz.).

By looking over Dr. Boyd's table it will be seen that heavy brains generally belong to tall men; and so, by our table of individuals, it appears that the heaviest is that of Turgeneff, who was a man of large size, while the lighter brains accompanied men of medium or short stature. Women are generally shorter than men, and their brains relatively smaller. Quatrefages says: "We have known for several years that the stature has an influence upon the weight of the brain. It can not be without influence upon the cavity by which the latter is inclosed. Under similar circumstances in other respects, the weight of the brain varies proportionately, or almost proportionately, to the height."

If we accept the above statement that the largest healthy brains are found in the tallest persons, and add to it the phrenological rule that brain-size is a true measure of mental power, it will follow that giants have the greatest minds in the world, which is contradicted by every day's experience. Dr. Ireland, in his work on idiocy and imbecility, mentions two cretins, each six feet high; several idiot Calibans, six feet six inches; several idiots described by Lomboso, one of whom was eight and a half feet, another seven feet eight inches, with a sister the same height. Large stature may be a general indication of large brain-weight, but the latter can not be taken as a safe index of high intellectual power.

EARTHQUAKES.

By Professor G. H. DARWIN, F. R. S.

THE earthquake-shocks which have recently occurred in America and Greece, and the great volcanic eruption in New Zealand, have served to keep the subject vividly before us during many months past, and have perhaps created in some alarmist minds an ungrounded expectation that the earth is about to enter on a new period of Plutonic activity. It is natural, then, to ask at the present time what is an earthquake, and what are its causes. Notwithstanding the necessary incompleteness in the answers which can be given to these questions, yet a good deal more is known than appears to be the common property of newspaper writers. The object, then, of the present article is

to give a rough sketch of the present state of knowledge in this complicated subject.

Although history abounds with more or less complete accounts of earthquakes, it is remarkable that hardly ten years have yet elapsed since an accurate record was first obtained of what actually occurs during an earthquake. The combination of circumstances is curious, by which a knot of Scotch students, working in Japan, has secured so considerable an advance in seismology. The incessant but usually non-destructive earthquakes by which Japan is visited, the strange Japanese *renaissance*, and the importation of foreign professors, thoroughly trained at the Scotch universities in an accurate perception of mechanical principles, are the three factors which have co-operated to bring about this result.

The Scoto-Japanese professors, of whom the most eminent are Ewing, Gray, and Milne, have studied their subject with admirable persistence, and have by their ingenuity placed seismologists in possession of instruments by which the motion of the ground during an earthquake is recorded on an accurate scale of time. Such instruments are called seismographs, or recording seismometers. During an earthquake the ground and all that is fixed to it move together, and at first sight it seems impossible to get anything to stay still during the vibration. An exact description of a scientific instrument would be out of place here, but a general notion of these seismographs may be easily grasped.

The horizontal pendulum of Zöllner, and a suggestion of Chaplin (also a professor in Japan), are the sources from which "the horizontal pendulum seismograph" of Ewing originated. The principles according to which it is constructed may be explained as follows: If we consider an open door which can swing on its hinges, and imagine that a sudden horizontal movement is given to the door-post, at right angles to the position in which the door is hanging, then it is clear that the outer edge of the door will begin to move with a sort of recoil in the direction opposite to that of the movement imparted to the door-post. Since the door-post moves in one direction, while the edge of the door recoils, somewhere in the door there is a vertical line which remains still. The exact position of this line depends on the proportion which the amount of the recoil of the outer edge bears to the direct motion of the door-post. Now, if the sudden movement is imparted to the door-post by means of the floor to which it is attached, it is clear that a pencil attached to the door at this vertical line will write on the floor the displacement of the door-post, notwithstanding that the floor has moved. If next we suppose that there are two such doors hanging at right angles to one another from the same door-post, and that a sudden horizontal movement *in any direction* is given to the floor, each pencil will write on the floor that part of the movement which was at right angles to its door. Lastly, if the floor or surface on which the record

is written is kept moving uniformly by clock-work, we obtain also a register in time as well as space.

But in an earthquake the surface of the earth undergoes also a vertical movement which has to be recorded. The principle by which an instrument may be constructed to attain this end is as follows: If a weight hangs by a long, elastic cord, so that when set dancing up and down it oscillates very slowly, then, when a sudden jerk is given to the point of support, the weight will for the moment stand almost stationary, and a pencil attached to it may write its record on a surface fastened to the part jerked. This idea has been utilized in the construction of a vertical seismograph, but various important modifications have been introduced for the purpose of annulling the spontaneous dance of the weight after the shock has occurred.*

It will undoubtedly serve to give an impulse to this science that henceforth the intending observer need not waste time in devising and constructing instruments, but can purchase the complete equipment of a seismological observatory, as recommended by Ewing, and may begin work at once.

Many other instruments besides these have been used for the observation of earthquakes, and among the best are those of Bertelli, Rossi, and Palmieri. An instrument which tells only that there has been a shock, without giving a record of the nature of the movement, is called a seismoscope. Some of the Italian instruments are seismoscopes, which, however, give an approximate idea of the severity and direction of the vibration, and others claim to be accurate seismographs or seismometers. But I do not think that any of them can compete with the instruments described in outline above.

And what do recording instruments tell us of the actual occurrences during an earthquake?

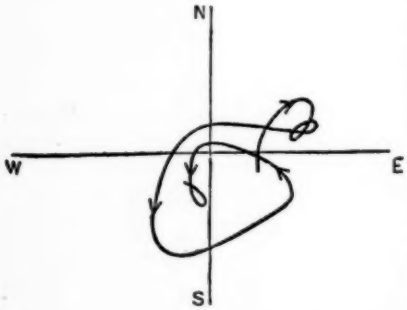
"They show," writes Ewing,† "that, as observed at a station on the surface of the earth, an earthquake consists of a very large number of successive vibrations—in some cases as many as three hundred have been distinctly registered. They are irregular both in period and amplitude, and the amplitude does not exceed a few millimetres" (a millimetre is one twenty-fifth of an inch), "even when the earthquake is of sufficient severity to throw down chimneys and crack walls, while in many instances the greatest motion is no more than the fraction of a millimetre. The periods of the principal motions are usually from half a second to a second, but . . . the early part of the disturbance often contains vibrations of much greater frequency. The earthquake generally begins and always ends very gradually, and it is a

* I make no attempt to apportion the credit among the several inventors of these instruments. The men mentioned have played the leading parts, and the work of all seems to be thorough and sound.

† "Memoirs of the Science Department of the University of Tokio," No. 9, 1883, p. 13.

noteworthy fact that there is in general no one motion standing out from the rest as greatly larger than those which precede and follow it. The direction of motion varies irregularly during the disturbance—so much so, that in a protracted shock the horizontal movements at a single station occur in all possible azimuths" (that is to say, to all points of the compass). "The duration, that is to say the time, during which the shaking lasts at any one point is rarely less than one minute, often two or three, and in one case in the writer's experience was as much as twelve minutes."

The horizontal path pursued, in an actual earthquake at Tokio, on March 8, 1881, by the part of the recording instrument which was fixed to the ground, is shown in the annexed figure.* It is magnified six fold, and the time occupied from the beginning to the end of this part of the vibration was three seconds. This earthquake, although alarming, did no damage except to crack a few walls.



It is obvious that when the motion is so complicated, the impressions of people present go for little as compared with an automatic record. Observers often differ widely among themselves as to what was the direction of the prevailing oscillation, and the magnitude of the displacement of the ground is generally much exaggerated. It is true that in some of the great historic earthquakes the displacements are supposed to have been considerable; for example, according to Mallet, in the Neapolitan shock of 1857 it amounted to a foot, and Abella assigns six feet as the amplitude in the Manila earthquake of 1881. But, without contesting the accuracy of these estimates, it is safe to say that such displacements are very rare, for, as proved by automatic seismographs, when the motion is as much as a quarter of an inch, brick and stone chimneys are generally shattered.

Every railway-traveler knows that it is not the steady speed, but the starting and stopping, which jars him; that is to say, it is change of velocity by which he is shaken. The misconception of an observer in an earthquake arises from the fact that the sensation of being tossed about comes from the change of velocity to which he is subjected, rather than from the extent of his displacement. Now, the greatest change per second of velocity may be considerable in a vibration, while the amplitude is small.

The force of gravity is the most familiar example of a change per second of velocity, for in each second the velocity of a falling body is augmented by a velocity of thirty-two feet a second. Ewing appears

† "Memoirs of the Science Department of the University of Tokio," No. 9, 1883, p. 58.

to have been the first to think of comparing the greatest change per second of velocity in an earthquake with gravity. Thus at Tokio, on March 11, 1882, walls were cracked and chimneys knocked over, and in this shock the greatest change per second of velocity may be expressed by the phrase one thirty-fifth of gravity; in other words, the greatest change per second of velocity was $\frac{32}{35}$ of a foot per second. This conclusion enables us also to illustrate the mechanical consequences of the shock in another way; for if a wall thirty-five feet high leans over, so that the top brick projects a foot beyond the bottom brick, the forces tending to upset the wall are the same as those which occurred in this earthquake.

No great shock has ever yet been recorded by automatic instruments, and it is not unlikely that in these great disasters the instruments would be thrown out of gear, and no record would be obtained. Thus, earthquakes which only work a moderate amount of destruction are the most favorable for scientific operation.

Since the oscillations at any one spot are usually in all sorts of directions, it is impossible, from observation at a single place, to form a sound opinion as to position of the origin of the disturbance. Much information useful for the study of vibrations and of the laws of their decrease with increasing distance, has resulted from a laborious series of experiments made by Milne at Tokio. Artificial earthquakes were produced by the explosion of gun-cotton in holes in the ground, and by the fall of heavy weights, and the records at various distances from the origin were obtained.

From theoretical considerations, confirmed by these experiments, it is established that earthquake-waves consist of oscillations of two kinds, namely, waves or vibrations of compression, and of distortion. In the first kind the motion of each particle of the ground is to and fro in the direction in which the wave is traveling; and in the second kind the excursions are at right angles to the direction of wave-propagation. As the former vibrations travel more rapidly than the latter, all the compressional waves may have passed a given station before the arrival of the distortional waves, and thus the shock may be apparently duplicated. Or, nearer to the origin, the two series will overlap, and a complex movement ensues, such as that exhibited in the figure above. The phenomena are further complicated by frequent reflections and refractions, as the wave passes from one geological stratum to another. The rate at which these waves travel depends on the nature of the rock through which the movement passes; velocities ranging from a mile per second to five miles per second are usual.

The destructive effects of earthquakes on buildings are notorious, and it is unnecessary to describe them here. By an examination of ruined buildings a competent observer is often able to obtain a good deal of information as to the nature of the shock. Thus Mallet visited the towns destroyed by the Neapolitan earthquake of 1857, and, by a

very careful consideration of the fractures in walls and other damage, was able to draw a number of interesting conclusions as to the directions and amplitudes of the principal vibrations and as to the site of the center of disturbance.

Architects should be able, by an adherence to sound mechanical principles, to construct buildings which should stand against all but the severest shocks, and much has already been done in this way. Where a choice for the site of an intended building is possible, the most important consideration is that it should be where there has been the greatest immunity from vibration on previous occasions, for, even within a very small area, different spots are very differently affected. In most regions there is only a single important center whence earthquakes originate, and the safe places are situated in what may be called earthquake-shadow for the prevalent vibrations. For just as a high wall, a hill, or a railway-cutting often completely cuts off sounds by forming a sound-shadow, so a ravine or some arrangement of the geological formation may afford earthquake-shadow for particular places.

It is not in general possible to pick out the favorable sites by mere inspection, for the distribution of vibration is often apparently capricious. Thus Milne tells us of a princely mansion at Tokio "which has so great a reputation for the severity of the shakings it receives, that its marketable value has been considerably depreciated, and it is now untenanted."*

In a town which is frequently shaken there is no need to wait long to carry out a rough survey with seismographs, and thus to obtain an idea of the relative shakiness of the various parts. If such a survey is impossible, it is best to avoid as the site for building a loose soil, such as gravel, resting on harder strata, and the edge of a scarp or bluff, or the foot of similar eminences.†

The same capriciousness of distribution, which is observable on a small scale, is found to hold on a large scale when we consider the distribution of earthquakes throughout a whole country. Regions subject to earthquakes, or seismic areas, appear to have fairly definite boundaries, which remain constant for long periods. For example, in Japan, earthquakes are rarely felt on the western side of the central range of mountains.

The search for the actual point whence the earthquake originated is one of the most interesting branches of the science. In order to trace the earthquakes in a country to their origin, the places of observation should not be chosen where there is comparative immunity from shaking. Thus a seismic survey is necessary, and the limits of the seismic areas will be discovered in the course of it. Milne commenced his survey of Japan by sending to the local government offices in the important towns, distant from thirty to a hundred miles from Tokio, packets

* Milne, "Earthquakes," p. 134. † Ibid., p. 144.

of post-cards, one of which was to be returned to him at the end of each week with a record of the shocks which had been felt. "The barricade of post-cards was then extended farther northward, with the result of surrounding the origin of certain shocks among the mountains, while others were traced to the sea-shore. By systematically pursuing earthquakes, it was seen that many shocks had their origin beneath the sea, . . . but it was seldom that they crossed through the mountains forming the backbone of the island."* When the country had been thus mapped out, it was possible to choose the most advantageous sites for the observatories.

It would carry us too far into technical matters to describe the method of searching into the bowels of the earth for the actual point of disturbance. It must here suffice to say that if a shock be accurately timed at various places, and if the approximately circular ring where it was most severe be determined, it is possible to find with fair accuracy the spot or spots under which it originated and the depth of the earthquake-center. Even without accurate time-observations, Mallet was able to show that the Neapolitan shock originated between three and seven miles below the surface. The Yokohama earthquake of 1880 appears to have had its center at a depth of from one and a half to five miles. Notwithstanding that one earthquake has been estimated as originating at a depth of fifty miles, it is probable that in all cases the center of shock is only a few miles below the surface.

The vagueness as to the position which has been assigned for the center of disturbance in the case of particular earthquakes probably depends less on the difficulty of tracing back the vibrations to their origin, than on the fact that the shocks do not usually originate in a single point, but rather along a line of a mile or two in length.

As to the way in which seismic activity is distributed geographically over the earth's surface, certain broad conclusions have been fairly well ascertained. If a map be shaded, so as to represent the frequency of earthquakes, we see that the shading has a tendency to fall into bands or ribbons, which generally follow the steeply sloping shores of continents and islands; and it is probable that the actual origins of the shocks are generally situated under the sea not far from the coast.

It is a further interesting peculiarity that the most important bands fall end to end, so that they may be regarded as a single ribbon embracing nearly half the earth. It may be suspected that this ribbon really meets itself and forms a closed curve, but this can not be proved as yet. We may begin to trace its course at Cape Horn, whence it follows the Andes along the whole western coast of South America. At the north of that continent it becomes somewhat broader, but its course is clearly marked along the line of the West Indies from Trinidad to Cuba. Hence it passes to the mainland in Mexico, and then runs along the whole western coast of North America. We then trace the line

* Milne, "Earthquakes," p. 189.

through the Aleutian Islands to Kamchatka, and thence southward through the Japanese Islands, the Philippines, and the Moluccas, to Sumatra and Java. Another branch seems to run from Sumatra, through New Guinea, to New Zealand, and the closed curve may perhaps be completed through the Antarctic regions, which are known to be volcanic. Returning to the first branch which we traced as far as Java, to the westward the seismic areas become more patchy and less linear. It may, however, perhaps be maintained that the ribbon runs on through India, Persia, Syria, the Eastern Mediterranean, Greece, and Italy.

This grouping of seismic areas into a ribbon does not comprise all the regions of earthquakes, but it must rather be taken as meaning that there is one great principal line of cracking of the earth's surface. In speaking here of earthquakes, those sensible shocks are meant which are sufficiently severe to damage buildings, for, as will be explained below, there is reason to believe that the whole earth is in a continual state of tremor.

Seismic areas are not absolutely constant in their limits, and cases are known where regions previously quiescent have become disturbed. It seems likely that the recent disastrous earthquake at Charleston belongs to the West Indian system of seismic activity, but there is no reason to suspect a permanent extension of the West Indian area so as to embrace the Southern States. On the contrary, it is far more probable that this disastrous shock will remain a unique occurrence. The previous experience of great earthquakes, such as that of Lisbon in the middle of the last century, shows, however, that the inhabitants of Charleston must for the next year or two expect the recurrence of slight shocks, and that the subterranean forces will then lull themselves to sleep again.

With regard to the distribution of earthquakes in time there is no evidence of either decrease or increase within historical periods, and although physical considerations would lead us to suppose that they were more frequent in early geological times, geology at least can furnish no proof that this has been the case.*

A great deal has been written on the causes of earthquakes, and many of the suggested theories seem fanciful in the highest degree. It is clear, however, that the primary cause resides in the upper layers of the earth, and that the motive power is either directly or indirectly the internal heat of the earth. The high temperature of the rocks, in those little scratches in the earth's surface which we call mines, proves the existence of abundant energy for the production of any amount of disturbance of the upper layers. It only remains to consider how that energy can be brought to bear. One way is by the slow shrinking of the earth, consequent on its slow cooling. Now, the heterogeneity of the upper layers makes it impossible that the shrinkage shall occur

* Geikie, "Contemporary Review," October, 1886.

with perfect uniformity all round. Thus, one part of the surface will go down before another, and as this must usually occur by a cracking and sudden motion, the result will be an earthquake.

The seismic ribbons of which we have spoken are probably lines of weakness along which cracking habitually takes place. Along these lines there are enormous dislocations of the geological strata, and earthquakes are known to follow lines of faulting. The geologically recent elevation of the Pacific coast of South America is obviously, from this point of view, connected with the abundance of volcanoes and the frequency of earthquakes along the chain of the Andes.

One would think that the continual ejection of lava and ashes from an active volcano must leave a hollow under the mountain, and that some day the cavern would suddenly collapse. It has, however, been observed that volcanic eruptions and severe earthquakes are to some extent alternatives, so that it seems as though the volcanic vent served as a safety-valve for the liberation of the dangerous matter. But the theory of the collapsing cavern must not be wholly rejected, for some disastrous earthquakes affecting only very restricted areas, such as that of Casamicciola in Ischia, are hardly otherwise explicable. In this case Palmieri has attributed the formation of the cavern to evisceration under the town produced by hot mineral springs.

In the theories of which we have just spoken, the internal heat of the earth acts indirectly, by giving to gravitation an opportunity of coming into play. But as in volcanic eruptions enormous quantities of steam are usually emitted, it is probable that the pressure of steam is the force by which the lava and ashes are vomited forth, and that the steam is generated when water has got among hot internal rocks. From this point of view we can understand that an eruption will serve as a protection against earthquakes, and that the centers of disturbance will usually be submarine.

It may on the whole be safely concluded that a diversity of causes are operative, and that some earthquakes are due to one and others to other causes.

It would, however, be certainly wrong to look only to the interior of the earth for the causation of earthquakes, since the statistics of earthquakes clearly point to connections with processes external to the solid earth.

The laborious inquiries of M. Perrey show that there are more earthquakes at the time of full and change of moon than at other times, more when the moon is nearest to the earth and more when she is on the meridian than at the times and seasons when she is not in those positions relatively to the earth. The excess of earthquakes at these times is, however, not great, and an independent investigation of the Japanese earthquakes does not confirm Perrey's results. It is well, therefore, still to hold opinion in suspense on this point. If, however, Perrey's result should be confirmed, we must attribute it to

the action of those forces which produce tides in the ocean, and therefore at the same time cause a state of stress in the solid earth.

Then again it is found that earthquakes are indubitably more apt to occur when there is a rapid variation of the pressure of the air, indicated by a rise or fall of the barometer, than in times of barometric quiescence. It is certain that earthquakes in both hemispheres are more frequent in the winter than in the summer; this is probably connected with the greater frequency of sudden rises and falls of the barometer at that season. It may, however, be urged against this view that volcanic eruptions are somewhat more frequent in the summer. But whatever be the action of these external processes with regard to earthquakes, it is certain that the connection between the two is merely that of the trigger to the gun. The internal energy stands waiting for its opportunity, and the attraction of the moon or the variation in atmospheric pressure pulls the trigger. Thus the predictions of disaster which have frequently been made for particular dates must be regarded as futile.

It has long been known that an earthquake is preluded by slight tremors leading by a gradual *crescendo* to the destructive shocks. But within the last fifteen years it has been discovered that the earth's surface is being continually shaken by tremors, so minute as to remain unsuspected without the intervention of the most delicate instruments. In every country where the experiment has been tried, these tremors have been detected, and not merely at certain periods, but so incessantly that there is never a second of perfect rest. The earth may fairly be said to tremble like a jelly. The pioneer in this curious discovery was Father Bertelli. His experiments relate only to Italy, but that which has been found true also of England, France, Egypt, Japan, Brazil, and a solitary island in the South Pacific Ocean, probably holds good generally, and we may feel sure that earth-tremors or "microseisms" are not confined to countries habitually visited by the grosser sort of earthquakes.

Almost all our systematic knowledge of microseisms comes from Italy, for a co-operation has been arranged there between many observers with ingenious instruments at their disposal. Besides Bertelli, the most eminent of the observers is Cavaliere Michele de Rossi, who has established at Rome a "Geodynamical Observatory," and has initiated as an organ of publication the "Bulletino del Vulcanismo Italiano," in whose pages are to be found contributions from Malvasia, Monte, Cecchi, Palmieri, Egidi, Galli, and many others. The literature which has already accumulated on the subject is extensive, and it will only be possible generally to indicate its scope.

The Italians have, of course, occupied themselves largely with earthquakes, but in that field their results do not present a great deal that is novel. The instruments in use for the observation of microseisms are scarcely to be classed as perfect seismographs or seismom-

eters, and the minuteness of the movements to be observed no doubt entails especial difficulties. The "normal tromometer" of Bertelli and Rossi is a simple pendulum, about six feet long, with an arrangement for observing the dance of the pendulum-bob with a microscope. With this and other instruments it has been established that the soil of Italy trembles incessantly. The agitation of the pendulum is usually relatively considerable for about ten days at a time; toward the middle of the period it increases in intensity, when there generally ensues an earthquake which can be perceived without instruments; the agitation then subsides. This has been called by Rossi a seismic period or seismic storm. After such a storm there ensues a period of a few days of relative quiescence.

The vibration of the pendulum in these storms is in general parallel to neighboring valleys or chains of mountains, and its intensity seems to be independent of wind, rain, and temperature. Care is of course taken not to mistake the tremors due to carts and carriages for microseismic agitation, and it has been found easy to effect this separation. The positions of the sun and moon exercise some influence on these tremors, but the most important concomitance which has been established is that they are especially apt to be intense when the barometer is low.

Microseismic storms are not strictly simultaneous at different places in Italy; but if a curve be constructed to represent the average intensity of agitation during each month, it is found on comparison of the curves for a year—for, say, Rome, Florence, and Leghorn—that there is a very close agreement between them.

Rossi has also made some interesting experiments with the microphone on microseisms. In this instrument one electrical conductor is arranged to rest on another at a single point—say, a nail resting on its point on a shilling. One copper wire is attached to the nail and another to the shilling, and an electric current, with an ordinary telephone receiver in the circuit, is then passed through the system. As long as the microphone is still, nothing is heard; but on the occurrence of the very slightest tremor, a noise is audible in the telephone. The instrument can be made so sensitive that a fly may be heard to walk near the microphone with a loud tramp, and a touch with a hair to the nail or to the shilling would sound like the grating of a harsh saw.

Rossi placed his microphone on the ground in a cavern sixty feet below the surface, on a lonely part of Rocca di Papa, an extinct volcano not far from Rome, while he listened with his telephone at the surface of the earth. He then heard the most extraordinary noises, which, as he says, revealed "natural telluric phenomena."

The sounds he describes as "roarings, explosions occurring isolated or in volleys, and metallic or bell-like sounds." They all occurred mixed together, and rose and fell in intensity at irregular intervals. He found it impossible by any artificial disturbance to a microphone

to produce the greater number of these noises. The microphone is especially sensitive to vertical movements of the soil, whereas the tromometer fails to reveal them. Nevertheless, there was more or less concordance between the agitations of the two instruments. In order, then, to determine the noises corresponding to various kinds of oscillation, he transported his microphone to Palmieri's Vesuvian observatory, where mild earthquakes are almost incessant; here he discovered that each class of shock had its characteristic noise. The vertical shocks gave the volleys of musketry and the undulatory shocks the roarings. By a survey with his microphone he concluded that the mountain is divided by lines of approximate stillness into regions where the agitation is great. If a metal plate dusted over with sand is set into vibration by a violin-bow rubbing on its edge, all the sand congregates into lines which mark out a pattern on the plate: these lines are nodes, or lines of stillness. It appears, then, that, when Vesuvius trembles with earthquake-shocks, its method of vibration is such that there are nodes of stillness.

At the Solfatara of Pozzuoli the sounds were extraordinarily loud; and the prevailing noise could be imitated by placing the microphone on the lid of a boiling kettle. Similar experiments have since been made by Milne in Japan with similar results.

Some years ago my brother Horace and I made some experiments at Cambridge with a pendulum, so arranged as to betray the minutest displacements. It was then but few years since Bertelli and Rossi had begun to observe; we had read no account of their work, and earth-tremors were quite unsuspected by us. Indeed, the object of our experiment, the measurement of the moon's attraction on a plummet, was altogether frustrated by these disturbances. The pendulum was successfully shielded from the shaking caused by traffic in the town, so that there was no perceptible difference in its behavior in the middle of the night on Sunday, and in the day-time during the week. We were then much surprised to find that the dance of the pendulum (for it was not a regular oscillation) was absolutely incessant. The agitation was more marked at some times than at others; the relatively large swinging, though absolutely very small, would continue for many days together, and this would be succeeded by a few days of comparative calm. In fact, we saw the seismic storms and calm of the Italians.* As the instrument was designed for another purpose, and was not quite appropriate for microseismic observation, we did not continue to note it after a month or two. But the substantial identity of the microseisms of England and Italy seems fairly well established.

The cause of these interesting vibrations are as yet but little understood, and it may be hoped that the subject will receive further attention. It seems probable that they are in part true microscopic earthquakes, produced by the seismic forces in the neighborhood.

* "Report to the British Association on the Lunar Disturbances of Gravity," 1881.

But they are also doubtless due to the reverberation of very distant shocks. It is probable that there is not a minute of time without its earthquake somewhere, and the vibrations may often be transmitted to very great distances. In only a very few cases has it hitherto been possible to identify a tremor with a distant shock, and even then the identification is necessarily rather doubtful. One of the best authenticated of these cases was when M. Nyrèn, an astronomer at St. Petersburg, noticed on May 10 (April 28), 1877, a very abnormal agitation of the levels of his telescope, an hour and fourteen minutes after there had been a very severe shock at Iquique, in Peru.

Astronomers are much troubled by slight changes in the level of the piers of their instruments, and they meet this inconvenience by continually reading their levels and correcting their results accordingly. Of course, they also take average results. These troublesome changes are probably earth-tremors, with so slow a motion to and fro that the term tremor becomes inappropriate. This kind of change has been called a displacement of the vertical, since a plummet moves relatively to the ground. Thus, we found at Cambridge that as the pendulum danced it slowly drifted in one direction or the other. There was a fairly regular daily oscillation, but the pendulum would sometimes reverse its expected course for a few minutes, or for an hour. During the whole time that we were observing, the mean position of the pendulum for the day slowly shifted in one direction; but even after a voyage of six weeks the total change was still excessively small. How far this was a purely local effect and how far general we had no means of determining.

This is a subject which M. d'Abbadie, of the French Institute, has made especially his own. Notwithstanding his systematic observations, carried on during many years in an observatory near the Bay of Biscay, on the French side of the Spanish frontier, hardly anything has been made out as to the laws governing displacements of the vertical. He has, however, been able to show that there is a tendency for deflection of the vertical toward the sea at high tide, but this deflection is frequently masked by other simultaneous changes of unexplained origin.

This result, and the connection between barometric variations and earthquakes and tremors, should make us reflect on the forces which are brought into play by the rise and fall of the tide and of atmospheric pressure. Our very familiarity with these changes may easily blind us to the greatness of the forces which are so produced. The sea rests on the ground, and when the tide is high there is a greater weight to be supported than when it is low. A cubic foot of water weighs 62 pounds; thus if high-tide be only ten feet higher than low-tide, every square foot of the sea-bottom supports 620 pounds more at high than at low water; and 620 pounds to the square foot is nearly 8,000,000 tons to the square mile. Again, the barometer ranges

through fully two inches, and a pool of mercury two inches deep and a square foot in area weighs 145 pounds; hence, when the barometer is very high, every square foot of the earth-surface supports about 140 pounds more than if it is low; and 140 pounds to the square foot is 1,800,000 tons to the square mile.

Now, rocks are not absolutely rigid against flexure, certainly less so than most of the metals, and these enormous weights have to be supported by the rocks. Taking a probable estimate for the elasticity of rocks, I have made some calculations as to the amount of effect that we may expect from this shifting of weights, and I find that it is likely that we are at least three or four inches nearer the earth's center when the barometer is very high than when it is very low.*

It may be that the incessant straining and unstraining of the earth's surface is partly the cause of earth-tremors, and we can at least understand that these strains may well play the part of the trigger for precipitating the explosion of the internal seismic forces. The calculations also show that near the sea-coast the soil must be tilted toward the sea at high-water, and that the angle of tilting may be such as could be detected by a delicate instrument like that of M. d'Abbadie.

This breathing of the solid earth seems to afford a wide field for scientific activity. It would be premature to speculate as to how far it will be possible to educe law from what is now chaotic; but it is clear that the co-operation of many observers will be required to separate the purely local from the true terrestrial changes. The directors of astronomical observatories have peculiar facilities for the study of displacements of the vertical, and it is to be regretted that hitherto most of them have been contented to banish, as far as may be, the troubles caused in their astronomical work by earth-tremors and displacements of the vertical.—*Fortnightly Review.*

* "Second Report to the British Association on Lunar Disturbances of Gravity," 1882.

Professor Judd, in his address at the last annual meeting of the Geological Society, showed that minerals are subject to physiological changes, analogous to those which take place in plants and animals, though differing in the form of their manifestation and the time they occupy. They have a life-history, he says, "which is in part determined by their original constitution, and in part by the long series of slowly-varying conditions to which they have since been subjected. In spite of the circumstance that their cycles of change have extended over periods measured by millions of years, the nature of their metamorphoses and the processes by which these have been brought about are, in all essential respects, analogous to those which take place in a sequoia or a butterfly." By this, he does not mean that minerals actually live, in the sense in which "living" is popularly understood; but that, like animals and plants, they go through definite cycles of change, dependent on their environment. Hence the distinction between "organic" or "living" matter, and "inorganic" or "lifeless" matter, is not fundamental.

NEW CHAPTERS IN THE WARFARE OF SCIENCE.

By ANDREW DICKSON WHITE,
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II.—METEOROLOGY.*

THE popular beliefs of classic antiquity regarding storms, thunder, and lightning, took shape in myths representing Vulcan as forging thunderbolts, Jupiter as flinging them at his enemies, Æolus intrusting the winds in a bag to Æneas, and the like. An attempt at their further theological development is seen in the Pythagorean statement that lightnings are intended to terrify the damned in Tartarus.

But, at a very early period, we see the beginning of a scientific view. In Greece, the Ionic philosophers held that such phenomena are obedient to law; Plato, Aristotle, and many lesser lights, attempted to account for them on natural grounds; and their explanations, though crude, were based upon observation and thought. In Rome, Lucretius, Seneca, Pliny, and others, inadequate as their statements were, implanted at least the germs of a science. But, as the Christian Church rose to power, this evolution was checked; the new leaders of thought found, in the Scriptures recognized by them as sacred, the basis for a new view, or rather for a modification of the old view.

This ending of a scientific evolution based upon observation and reason, and this beginning of a sacred science based upon the letter of Scripture and on theology, are seen in the utterances of various Fathers in the early Church. As to the general features of this new development, Tertullian held that sundry passages of Scripture prove lightning identical with hell-fire;† and this idea was transmitted from generation to generation of later churchmen, who found an especial support of Tertullian's view in the sulphurous smell experienced during thunderstorms.‡ Saint Hilarion thought the firmament very much lower than the heavens, and that it was created for the support of the upper waters, as well as for the tempering of our atmosphere.* Saint Ambrose held the firmament to be a solid vault, and the thunder to be caused by the winds breaking through it; citing from the prophet Amos the sublime passage regarding "Him that establisheth the thunders."‖ He shows, indeed, some conception of the true source of rain; but his whole reasoning is limited by various scriptural texts. He lays great stress upon the firmament as a solid outer shell of the universe: the heavens he holds to be not far outside this outer shell, and argues regarding their

* See "The Popular Science Monthly" for October, 1885.

† See Tertullian, "Apol. contra gentes," c. 47.

‡ See, for example, Augustin de Angelis, "Lectura Meteorologia," 64.

* See Hilarion, "In Psalm," cxxxv (Migne, "Patr. Lat.," ix, 773).

‖ "Firmans tonitrua" (Amos iv, 13); the phrase does not appear in our version.

character from Saint Paul's Epistle to the Corinthians and from the one hundred and forty-eighth Psalm. As to "the waters which are above the firmament," he takes up the objection of those who hold that, this outside of the universe being spherical, the waters must slide off it, especially if the firmament revolves; and he points out that it is by no means certain that the *outside* of the firmament *is* spherical, and insists that, if it does revolve, the water is just what is needed to lubricate and cool its axis.*

Saint Jerome held that God at the creation spread out the firmament between heaven and earth, separating the upper waters from the lower, and that, in order to keep all in place, He caused the upper waters to be frozen into ice. A proof of this view Jerome found in the words of Ezekiel regarding "the crystal stretched above the cherubim."†

The germinal principle in accordance with which all these theories were evolved, was most clearly proclaimed to the world by Saint Augustine in his famous utterance, "Nothing is to be accepted save on the authority of Scripture, since greater is that authority than all the powers of the human mind."‡ No treatise was safe thereafter which did not breathe the spirit and conform to the letter of this maxim. Unfortunately, what was generally meant by the "authority of Scripture," was the tyranny of a literature imperfectly transcribed, viewed through distorting superstitions, and frequently interpreted by party spirit.

Following this precept, Saint Augustine developed, in every field, theological views of science which have never led to a single truth—which, without exception, have forced mankind away from the truth, and have caused Christendom to stumble for centuries into abysses of error and sorrow. In meteorology, as in every other science with which he dealt, he based everything upon the letter of the sacred text; and it is characteristic of the result that this man, so great when untrammeled, thought it his duty to guard especially the whole theory of the "waters above the heavens."

In the sixth century this theological reasoning was still further developed by Cosmas Indicopleustes. Basing his theory of the universe upon the ninth chapter of Hebrews, he insisted that the earth is flat, a parallelogram, and that from its outer edges rise immense walls

* See Ambrose, "Hexæmeron," ii, 3, 4; iii, 5 (Migne, "Patr. Lat.," xiv, 148–150, 153, 165). The passage as to lubrication of the heavenly axis is as follows: "Deinde cum ipsi dicant volvi orbem cœli stellis ardentibus refulgentem, nonne divina providentia necessario prospexit, ut intra orbem cœli, et supra orbem redundaret aqua, quæ illa ferventis axis incendia temperaret?"

† See Jerome, "Epistola," lxix, 6 (Migne, "Patr. Lat.," xxii, 659).

‡ "Major est quippe Scripturæ hujus auctoritas, quam omnis humani ingenii capacitas."—Augustine, "De Genesi ad Lit.," ii, 5 (Migne, "Patr. Lat.," xxxiv, 266, 267). Or, as he is cited by Vincent of Beauvais ("Spec. Nat.," iv, 98): "Non est aliquid temere diffiniendum, sed quantum Scriptura dicit accipiendum, cujus major est auctoritas quam omnis humani ingenii capacitas."

supporting the firmament; then, throwing together the reference to the firmament in Genesis and the outburst of poetry in the Psalms regarding the "waters that be above the heavens," he insisted that over the terrestrial universe are solid arches bearing a vault, closing it in and supporting a vast cistern "containing the waters"; finally, taking from Genesis the expression regarding the "windows of heaven," he insisted that these windows are opened and closed by the angels whenever the Almighty wishes to send rain upon the earth or to withhold it.*

This was accepted by the universal Church as a vast contribution to thought; for over a thousand years it was the orthodox doctrine, and various leaders in theology devoted themselves to developing and supplementing it.

About the beginning of the seventh century, Isidore, Bishop of Seville, was the ablest prelate in Christendom, and was showing those great qualities which led to his enrollment among the saints of the Church. His theological view of science marks an epoch. As to the "waters above the firmament," Isidore contends that they must be lower than the uppermost heaven, though higher than the lower heaven, because in the one hundred and forty-eighth Psalm they are mentioned *after* the heavenly bodies and the "heaven of heavens," but *before* the terrestrial elements. As to their purpose, he hesitates between those who held that they were stored up there by the prescience of God for the destruction of the world at the flood, as the words of Scripture that "the windows of heaven were opened" seemed to indicate, and those who held that they were kept there to moderate the heat of the heavenly bodies. As to the firmament, he is in doubt whether it envelops the earth "like an egg-shell," or is merely spread over it "like a curtain"; for he holds that the passage in the one hundred and fourth Psalm may be used to support either view.

Having laid these scriptural foundations, Isidore shows considerable power of thought; indeed, at times, when he discusses the rainbow, rain, hail, snow, and frost, his theories are rational, and give evidence that, if he could have broken away from his adhesion to the letter of Scripture, he might have given a vast impulse to the evolution of a true science.†

About a century later appeared, at the other extremity of Europe, the second in the trio of theological men of science in the early middle ages, Bede the Venerable. The nucleus of his theory also is to be found in the accepted view of the "firmament" and of the "waters above the heavens," derived from Genesis; the firmament he holds to be spherical, and of a nature subtile and fiery; the upper heavens, he says, which contain the angels, God has tempered with ice, lest they

* See Cosmas, "Topographia Christiana" (in Montfaucon, "Collectio nova patrum," ii).

† See Isidore, "Etymologiæ," xiii, 7–9, "De ordine creaturarum," 3, 4, and "De natura rerum," 29, 30 (Migne, "Patr. Lat.," lxxxii, 476, 477, lxxxiii, 920–922, 1001–1003).

inflame the lower elements; as to the waters placed above the firmament, lower than the spiritual heavens, but higher than all corporeal creatures, he says, "Some declare that they were stored there for the deluge, but others, more correctly, that they are intended to temper the fire of the stars." He goes on with long discussions as to various elements and forces in Nature, and dwells at length upon the air, of which he says that the upper, serene air is over the heavens; that the other, which is coarse with humid exhalations, is sent off from the earth, and that in this are lightning, hail, snow, ice, and tempests, finding proof of this in the one hundred and forty-eighth Psalm, where these are commanded to "praise the Lord from the earth." *

So great was Bede's authority that nearly all the anonymous speculations of the next following centuries upon these subjects were eventually ascribed to him. In one of these spurious treatises an attempt is made to get new light upon the sources of the waters above the heavens, the main reliance being the sheet containing the animals let down from heaven, in the vision of Saint Peter. Another of these treatises is still more curious, for it endeavors to account for earthquakes and tides by means of the Leviathan mentioned in Scripture. This characteristic passage runs as follows: "Some say that the earth contains the animal Leviathan, and that he holds his tail after a fashion of his own, so that it is sometimes scorched by the sun, whereupon he strives to get hold of the sun, and so the earth is shaken by the motion of his indignation; he drinks in also, at times, such huge masses of the waves that when he belches them forth all the seas feel their effect." † And this theological theory of the tides, as caused by the alternate suction and belching of Leviathan went far and wide.

In the writings thus covered with the name of Bede, there is much showing a scientific spirit, which might have come to something of permanent value had it not been hampered by the supposed necessity of conforming to the letter of Scripture. It is as startling as it is refreshing to hear one of these mediæval theorists burst out against those who are content to explain everything by the power of God, as follows: "What is more pitiable than to say that a thing *is*, because God is able to do it, and not to show any reason why it is so, nor any purpose for which it is so; just as if God did everything that he is able to do! You talk like one who says that God is able to make a calf out of a log. But *did* he ever do it? Either, then, show a reason why a thing is so, or a purpose wherefore it is so, or else cease to declare it so." ‡

* See Bede, "De natura rerum" (Migne, "Patr. Lat.," xc).

† See the treatise "De mundi constitutione," in Bede's "Opera" (Migne, "Patr. Lat.," xc, 884).

‡ See "Elementa philosophiæ," in Bede's "Opera" (Migne, "Patr. Lat.," xc, 1139). This treatise, which has also been printed, under the title of "De philosophia mundi," among the works of Honorius of Autun, is believed by modern scholars (Hauréau, Werner, Poole) to be the production of William of Conches.

The most permanent contribution of Bede to scientific thought in this field was his revival of the view that the firmament is made of ice; and he supported this from the words in the twenty-sixth chapter of Job, "He bindeth up the waters in his thick cloud, and the cloud is not rent under them."

About the beginning of the ninth century appeared the third in that triumvirate of churchmen who were the oracles of sacred science throughout the early middle ages—Rabanus Maurus, Abbot of Fulda and Archbishop of Mayence. Starting, like all his predecessors, from the first chapter of Genesis, borrowing here and there from the ancient philosophers, and excluding everything that could conflict with the letter of Scripture, he follows, in his work upon the universe, his two predecessors, Isidore and Bede, developing especially Bede's theory that the firmament is strong enough to hold up the "waters above the heavens," because it was made of ice.*

For centuries the authority of these three great teachers was unquestioned, and in countless manuals and catechisms their doctrine was translated and diluted for the common mind. † But, about the second quarter of the twelfth century, a priest, Honorius of Autun, produced several treatises which show that thought on this subject had made some little progress. He explained the rain rationally, and mainly in the modern manner; with the thunder he is less successful, but insists that the thunderbolt "is not stone, as some assert." His thinking is vigorous and independent.‡ Had theorists such as he been many, a new science could have been rapidly evolved, but the theological current was too strong.

The strength of this current which overwhelmed the thought of Honorius is seen again in the work of the Dominican monk, John of San Geminiano, who in the thirteenth century gave forth his "Summa de Exemplis" for the use of preachers in his order. Of its thousand pages, over two hundred are devoted to illustrations drawn from the heavens and the elements. A characteristic specimen is his explanation of the Psalmist's phrase, "The arrows of the thunder." These, he tells us, are forged out of a dry vapor rising from the earth and kindled by the heat of the upper air, which then, coming into contact with a cloud just turning into rain, "is conglutinated like flour into dough," but, being too hot to be extinguished, its particles become

* See Rabanus Maurus, "Comment. in Genesim" and "De Universo" (Migne, "Patr. Lat.," cvii, cxi).

† For a charmingly *naïve* example of these primers, see the little Anglo-Saxon manual of astronomy, sometimes attributed to Ælfric. It is in the vernacular, but is translated in Wright's "Popular Treatises on Science during the Middle Ages." Bede is, of course, its chief source.

‡ See Honorius Augustodunensis, "De imagine mundi," and "Hexæmeron" (Migne, "Patr. Lat.," clxxii). The "De philosophia mundi," the most rational of all, is, however, believed by modern scholars to be unjustly ascribed to him. See note above.

merely sharpened at the lower end, and so blazing arrows, cleaving and burning everything they touch."*

But far more important in the thirteenth century was the fact that the most eminent scientific authority of that age, Albert the Great, Bishop of Ratisbon, attempted to reconcile the speculations of Aristotle with the theological views derived from the fathers. In one very important respect he improved upon the meteorological views of his great master. The thunderbolt, he says, is no mere fire, but the product of black clouds containing much mud, which, when it is baked by the intense heat, forms a fiery black or red stone that falls from the sky, tearing beams and crushing walls in its course: such he has seen with his own eyes.†

The monkish encyclopedists of the later middle ages added little to these theories. As we glance over the pages of Vincent of Beauvais, Bartholomew of Glanville, and William of Conches, we note only a growing deference to the authority of Aristotle as supplementing that of Isidore and Bede and explaining sacred Scripture. Aristotle is treated like a church Father, but extreme care is taken not to go beyond the great maxim of Saint Augustine; then, little by little, Bede and Isidore fall into the background, Aristotle fills the whole horizon, and his utterances are second in sacredness only to the text of Holy Writ.

A curious illustration of the difficulties these mediæval scholars had to meet in reconciling the scientific theories of Aristotle with the letter of the Bible is seen in the case of the rainbow. It is to the honor of Aristotle that his conclusions regarding the rainbow, though slightly erroneous, were based upon careful observation and evolved by reasoning alone; but his Christian commentators, while anxious to follow him, were brought up against the scriptural statement that God had created the rainbow as a sign to Noah that there should never again be a Flood on the earth. Even so bold a thinker as Cardinal Pierre d'Ailly, whose speculations as to the geography of the earth did so much afterward in stimulating Columbus, faltered before this statement, acknowledging that God alone could explain it; but suggested that possibly never before the deluge had a cloud been suffered to take such a position toward the sun as to cause a rainbow.‡

The learned cardinal was also constrained to believe that certain stars and constellations have something to do in causing the rain, since these would best explain Noah's foreknowledge of the Deluge. In connection with this scriptural doctrine of winds came a scriptural

* See Joannes à S. Geminiano, "Summa," c. 75.

† See Albertus Magnus, "II Sent.," Opp. xv, 137, a. (cited by Heller, "Gesch. d. Physik," i, 184) and his "Liber Methaurorum," III, iv, 18 (of which I have used the edition of Venice, 1488).

‡ See his "Concordia astronomicæ veritatis cum theologia" (Paris, 1483—in his "Imago mundi"—and Venice, 1490); also Eck's commentary on Aristotle's "Meteorologica" (Augsburg, 1519).

doctrine of earthquakes: they were believed to be caused by winds issuing from the earth, and this view was based upon the passage in the one hundred and thirty-fifth Psalm, "He bringeth the wind out of his treasuries."*

Such were the main typical attempts during nearly fourteen centuries to build up under theological guidance and within scriptural limitations a sacred science of meteorology. But these theories were mainly evolved in the effort to establish a basis and general theory of phenomena: it still remained to account for special manifestations, and here came a development of theological thought far more important.

This development was twofold: on the one hand, these phenomena were attributed to the Almighty; and, on the other, to Satan. As to the first of these theories, we constantly find the divine wrath mentioned by the earlier fathers as the cause of lightning, hail-storms, hurricanes, and the like.

At the very beginning of Christianity we see a curious struggle between pagan and Christian belief upon this point. Near the close of the second century the Emperor Marcus Aurelius, in his effort to save the empire, fought a hotly-contested battle with the Quadi, in what is now Hungary. While the issue of this great battle was yet doubtful, there came suddenly a blinding storm beating into the faces of the Quadi. This gave the Roman troops the advantage, and enabled Marcus Aurelius to win a decisive victory. Votaries of each of the great religions claimed that this storm was caused by the object of their own adoration. The pagans insisted that Jupiter had sent the storm in obedience to their prayers, and on the Antonine Column at Rome we may still see the figure of Olympian Jove casting his thunderbolts and pouring a storm of rain from the open heavens against the Quadi. On the other hand, the Christians insisted that the storm had been sent by Jehovah in obedience to *their* prayers; and Tertullian, Eusebius, Saint Gregory of Nyssa, and Saint Jerome were among those who insisted upon this meteorological miracle—the first two, indeed, in the fervor of their arguments for its reality, allowing themselves to be carried considerably beyond exact historical truth.†

As time went on, the Fathers developed this view more and more from various texts in the Jewish and Christian sacred books, substituting for Jupiter flinging his thunderbolts the Almighty wrapped in thunder and sending forth his lightnings. Through the middle ages this was fostered until it became a mere truism, entering into all me-

* See Reisch, "Margarita philosophica," ix, 18, and Eck, "Arist. Meteor." (as above), ii, nota 2.

† For the authorities, pagan and Christian, see the note of Merivale, in his "History of the Romans under the Empire," chap. lxviii. He refers, for still fuller citations, to Fynes Clinton's "Fast. Rom.," p. 24.

diæval thinking, and was still further developed by an attempt to specify the particular sins which were thus punished. In the twelfth century the Florentine historian, Villani, ascribed floods and fires to the "too great pride of the city of Florence and the ingratitude of the citizens toward God," which, "of course," says a recent historian, "meant their insufficient attention to the ceremonies of religion."*

In the thirteenth century the Cistercian monk, Cæsar of Heisterbach, popularized the doctrine in Central Europe. His rich collection of anecdotes for the illustration of religious truths was the favorite recreative reading in the convents for three centuries, and exercised great influence over the thought of the later middle ages; and in this work he relates several instances of the divine use of lightning, both for rescue and for punishment. Thus he tells us how the steward (*cellerarius*) of his own monastery was saved from the clutch of a robber by a clap of thunder which, in answer to his prayer, burst suddenly from the sky and frightened the bandit from his purpose; how, in a Saxon theatre, twenty men were struck down, while a priest escaped, not because he was not a greater sinner than the rest, but because the thunderbolt had respect for his profession! It is Cæsarius, too, who tells us the story of the priest of Treves, struck by lightning in his own church, whither he had gone to ring the bell against the storm, and whose sins were revealed by the course of the lightning; for it tore his clothes from him and consumed certain parts of his body, showing that the sins for which he was punished were vanity and unchastity.†

This mode of explaining the divine interference more minutely is developed century after century, and we find both Catholics and Protestants assigning as causes of unpleasant meteorological phenomena whatever appears to them wicked, or even unorthodox. Among the English reformers, Tyndale quotes in this kind of argument the thirteenth chapter of I. Samuel, showing that, when God gave Israel a king, it thundered and rained.‡ Archbishop Whitgift, Bishop Bale, and Bishop Pilkington insisted on the same view.* In Protestant Germany, about the same period, Plieninger took a dislike to the new Gregorian calendar, and published a volume of "Brief Reflections," in which he insisted that the elements had given utterance to God's anger against it, calling attention to the fact that violent storms raged over almost all Germany during the very ten days which the Pope had taken out for the correction of the year, and that great floods began with the first days of the corrected year.‖

* See Trollope, "History of Florence," i, 64.

† See Cæsarius Heisterbacensis, "Dialogus miraculorum," x, c. 28–30.

‡ See Tyndale, "Doctrinal Treatises," 194 (in Parker Society publications).

* See Whitgift, "Works," 477–483; Bale, "Works," 244, 245; and Pilkington, "Works," 177, 536 (both in Parker Society publications). Bishop Bale cites especially Job xxxviii, Ecclesiasticus xiii, and Revelation viii, as supporting the theory.

‖ See Janssen, "Geschichte des deutschen Volkes," v, 350, for Plieninger's words.

Early in the seventeenth century, Majoli, Bishop of Voltoraria, in southern Italy, produced his huge work, "Dies Canicularii," or "Dog-Days," which remained a favorite encyclopædia in Catholic lands for over a hundred years. Treating of thunder and lightning, he compares them to bombs against the wicked, and says that the thunderbolt is "an exhalation condensed and cooked into stone," and that "it is not to be doubted that, of all instruments of God's vengeance, the thunderbolt is the chief"; that by means of it Sennacherib and his army were consumed; that Luther was struck by lightning in his youth as a caution against departing from the Catholic faith; that blasphemy and Sabbath-breaking are the sins to which this punishment is especially assigned, and he cites the case of Dathan and Abiram.* Fifty years later the Jesuit Stengel developed this line of thought still further in four thick quarto volumes on the judgments of God, adding an elaborate schedule for the use of preachers in the sermons of an entire year. Three chapters were devoted to thunder, lightning, and storms. That the author teaches the agency in these of diabolical powers goes without saying; but this can only act, he declares, by divine permission, and the thunderbolt is always the finger of God, which rarely strikes a man save for his sins, and the nature of the special sin thus punished may be inferred from the bodily organs smitten.† A few years later, in Protestant Swabia, Pastor George Nuber issued a whole volume of "weather-sermons," in which he discusses nearly every sort of elemental disturbances—storms, floods, droughts, lightning, and hail. These, he says, come direct from God for human sins, yet no doubt with discrimination, for there are five sins which God especially punishes with lightning and hail, namely, impenitence, incredulity, neglect of the repair of churches, fraudulence in the payment of tithes to the clergy, and oppression of subordinates, each of which points he supports with a mass of scriptural texts.‡

This doctrine having become especially precious both to Catholics and to Protestants, there were issued hand-books of prayers against bad weather: among these was the "Spiritual Thunder and Storm Booklet," produced in 1731 by a Protestant scholar, Stöltzlin, whose three or four hundred pages of prayer and song, "sighs for use when it lightens fearfully," and "cries of anguish when the hail-storm is drawing on," show a wonderful adaptability to all possible meteorological emergencies. The preface of this volume is contributed by Professor Dilherr, pastor of the great church of St. Sebald at Nuremberg, who, in discussing the divine purposes of storms, adds to the three usually assigned—namely, God's wish to manifest his power, to display his anger, and to drive sinners to repentance—a fourth, which, he says, is

* See Majoli, "Dies Can.," I, i.

† See Stengelius, "De judiciis divinis," ii, 15–61, and especially the example of the "*impurus et saltator sacerdos, fulmine castratus*" (pp. 26, 27).

‡ See Nuber, "Conciones meteoricæ" (Ulm, 1661).

that God may show us "with what sort of a storm-bell he will one day ring in the last judgment." *

About the end of the first quarter of the eighteenth century, we find, in Switzerland, even the eminent and rational Professor of Mathematics, Scheuchzer, publishing a "Physica Sacra," with the Bible as a basis, and forced to admit that the elements, in the most literal sense, utter the voice of God. The same pressure was felt in New England. Typical are the sermons of Increase Mather on "The Voice of God in Stormy Winds." He especially lays stress on the voice of God speaking to Job out of the whirlwind, and upon the text, "Wind and storm fulfilling his word." He declares, "When there are great tempests, the angels oftentimes have a hand therein, . . . yea, and sometimes evil angels." He gives several cases of blasphemers struck by lightning, and says, "Nothing can be more dangerous for mortals than to condemn dreadful providences, and, in particular, dreadful tempests." †

His distinguished son, Cotton Mather, disentangled himself somewhat from the old view, as he had done in the interpretation of comets.‡ In his "Christian Philosopher," his "Thoughts for the Day of Rain," and his "Sermon preached at the Time of the Late Storm" (in 1723), he is evidently tending toward the modern view. Yet, from time to time, the older view has reasserted itself; and in France, as recently as the year 1870, we find the Bishop of Verdun ascribing the drought afflicting his diocese to the sin of Sabbath-breaking.

This theory, which attributed injurious meteorological phenomena mainly to the purposes of God, was a natural development, and comparatively harmless; but at a very early period there was evolved another theory, which, having been ripened into a doctrine, cost the earth dear indeed. Never, perhaps, in the modern world has there been a dogma more prolific of physical, mental, and moral agony throughout whole nations and during whole centuries.* This theory, its development by theology, its fearful results to mankind, and its destruction by scientific observation and thought, will form the subject of my next chapter.

* See Stöltzlin, "Geistliches Donner- und Wetter-Büchlein" (Zürich, 1731).

† See Increase Mather, "The Voice of God," etc. (Boston, 1704). This rare volume is in the rich collection of the American Antiquarian Society at Worcester.

‡ See a chapter on this subject, by the present writer, in "The Popular Science Monthly" for October, 1885. A new edition, with large additions, has been recently published by the American Historical Association.

* See the "Semaine relig. de Lorraine," 1870, p. 445 (cited by "Paul Parfait," in his "Dossier des Pèlerinages," 141–143).

M. Wroblewski has made a successful application of the electric light to the magic-lantern projection of opaque objects. In the midst of darkness a strong light is concentrated on the object, which becomes intensely illuminated, and its picture may be thrown upon the canvas with the colors fully brought out and even made more brilliant.

MENTAL DIFFERENCES OF MEN AND WOMEN.

By GEORGE J. ROMANES.

IN his "Descent of Man" Mr. Darwin has shown at length that what Hunter termed secondary sexual characters occur throughout the whole animal series, at least as far down in the zoölogical scale as the Articulata. The secondary sexual characters with which he is chiefly concerned are of a bodily kind, such as plumage of birds, horns of mammals, etc. But I think it is evident that secondary sexual characters of a mental kind are of no less general occurrence. Moreover, if we take a broad view of these psychological differences, it becomes instructively apparent that a general uniformity pervades them—that while within the limits of each species the male differs psychologically from the female, in the animal kingdom as a whole the males admit of being classified, as it were, in one psychological species and the females in another. By this, of course, I do not mean that there is usually a greater psychological difference between the two sexes of the same species than there is between the same sexes of different species: I mean only that the points wherein the two sexes differ psychologically are more or less similar wherever these differences occur.

It is probably due to a recognition of this fact that from the very earliest stages of culture mankind has been accustomed to read into all nature—inanimate as well as animate—differences of the same kind. Whether it be in the person of Maya, of the pagan goddesses, of the Virgin Mary, or in the personifications of sundry natural objects and processes, we uniformly encounter the conception of a feminine principle coexisting with a masculine in the general frame of the cosmos. And this fact, as I have said, is presumably due to a recognition by mankind of the uniformity as well as the generality of psychological distinction as determined by sex.

I will now briefly enumerate what appeared to me the leading features of this distinction in the case of mankind, adopting the ordinary classification of mental faculties as those of intellect, emotion, and will.

Seeing that the average brain-weight of women is about five ounces less than that of men, on merely anatomical grounds we should be prepared to expect a marked inferiority of intellectual power in the former.* Moreover, as the general physique of women is less robust

* This is proportionally a greater difference than that between the male and female organisms as a whole, and the amount of it is largely affected by grade of civilization—being least in savages and most in ourselves. Moreover, Sir J. Crichton Browne informs me, as a result of many observations which he is now making upon the subject, that not only is the gray matter, or cortex, of the female brain shallower than that of the male,

than that of men—and therefore less able to sustain the fatigue of serious or prolonged brain-action—we should also, on physiological grounds, be prepared to entertain a similar anticipation. In actual fact we find that the inferiority displays itself most conspicuously in a comparative absence of originality, and this more especially in the higher levels of intellectual work. In her powers of acquisition the woman certainly stands nearer to the man than she does in her powers of creative thought, although even as regards the former there is a marked difference. The difference, however, is one which does not assert itself till the period of adolescence—young girls being, indeed, usually more acquisitive than boys of the same age, as is proved by recent educational experiences both in this country and in America. But as soon as the brain, and with it the organism as a whole, reaches the stage of full development, it becames apparent that there is a greater power of amassing knowledge on the part of the male. Whether we look to the general average or to the intellectual giants of both sexes, we are similarly met with the general fact that a woman's information is less wide, and deep, and thorough, than that of a man. What we regard as a highly-cultured woman is usually one who has read largely but superficially ; and even in the few instances that can be quoted of extraordinary female industry—which, on account of their rarity, stand out as exceptions to prove the rule—we find a long distance between them and the much more numerous instances of profound erudition among men. As musical executants, however, I think that equality may be fairly asserted.

But it is in original work, as already observed, that the disparity is most conspicuous. For it is a matter of ordinary comment that in no one department of creative thought can women be said to have at all approached men, save in fiction. Yet in poetry, music, and painting, if not also in history, philosophy, and science, the field has always been open to both.* For, as I will presently show, the disabilities under which women have labored with regard to education, social opinion, and so forth, have certainly not been sufficient to explain this general dearth among them of the products of creative genius.

Lastly, with regard to judgment, I think there can be no real ques-

but also receives less than a proportional supply of blood. For these reasons, and also because the differences in question date from an embryonic period of life, he concludes that they constitute "a fundamental sexual distinction, and not one that can be explained on the hypothesis that the educational advantages enjoyed either by the individual man or by the male sex generally through a long series of generations have stimulated the growth of the brain in the one sex more than in the other."

* The disparity in question is especially suggestive in the case of poetry, seeing that this is the oldest of the fine arts which have come down to us in a high degree of development, that its exercise requires least special education or technical knowledge, that at no level of culture has such exercise been ostracized as unfeminine, that nearly all languages present several monuments of poetic genius of the first order, and yet that no one of these has been reared by a woman.

tion that the female mind stands considerably below the male. It is much more apt to take superficial views of circumstances calling for decision, and also to be guided by less impartiality. Undue influence is more frequently exercised from the side of the emotions; and, in general, all the elements which go to constitute what is understood by a characteristically judicial mind of comparatively feeble development. Of course, here, as elsewhere, I am speaking of average standards. It would be easy to find multitudes of instances where women display better judgment than men, just as in the analogous cases of learning and creative work. But that as a general rule the judgment of women is inferior to that of men has been a matter of universal recognition from the earliest times. The man has always been regarded as the rightful lord of the woman, to whom she is by nature subject, as both mentally and physically the weaker vessel; and when in individual cases these relations happen to be inverted, the accident becomes a favorite theme for humorists—thus showing that in the general estimation such a state of matters is regarded as incongruous.

But if woman has been a loser in the intellectual race as regards acquisition, origination, and judgment, she has gained, even on the intellectual side, certain very conspicuous advantages. First among these we must place refinement of the senses, or higher evolution of sense-organs. Next we must place rapidity of perception, which no doubt in part arises from this higher evolution of the sense-organs—or, rather, both arise from a greater refinement of nervous organization. Houdin, who paid special attention to the acquirement of rapidity in acts of complex perception, says he has known ladies who, while seeing another lady "pass at full-speed in a carriage, could analyze her toilet from her bonnet to her shoes, and be able to describe not only the fashion and quality of the stuffs, but also to say if the lace were real or only machine-made." Again, reading implies enormously intricate processes of perception, both of the sensuous and intellectual order; and I have tried a series of experiments, wherein reading was chosen as a test of the rapidity of perception in different persons. Having seated a number of well-educated individuals round a table, I presented to them successively the same paragraph of a book, which they were each to read as rapidily as they could, ten seconds being allowed for twenty lines. As soon as time was up I removed the paragraph, immediately after which the reader wrote down all that he or she could remember of it. Now, in these experiments, where every one read the same paragraph as rapidly as possible, I found that the palm was usually carried off by the ladies. Moreover, besides being able to read quicker, they were better able to remember what they had just read—that is, to give a better account of the paragraph as a whole. One lady, for example, could read exactly four times as fast as her husband, and could then give a better account even of that portion of the paragraph which alone he had had time to get through. For the

consolation of such husbands, however, I may add that rapidity of perception as thus tested is no evidence of what may be termed the deeper qualities of mind—some of my slowest readers being highly distinguished men.

Lastly, rapidity of perception leads to rapidity of thought, and this finds expression on the one hand in what is apt to appear as almost intuitive insight, and on the other hand in that nimbleness of mother-wit which is usually so noticeable and often so brilliant an endowment of the feminine intelligence, whether it displays itself in tact, in repartee, or in the general alacrity of a vivacious mind.

Turning now to the emotions, we find that in woman, as contrasted with man, these are almost always less under control of the will—more apt to break away, as it were, from the restraint of reason, and to overwhelm the mental chariot in disaster. Whether this tendency displays itself in the overmastering form of hysteria, or in the more ordinary form of comparative childishness, ready annoyance, and a generally unreasonable temper—in whatever form this supremacy of emotion displays itself, we recognize it as more of a feminine than a masculine characteristic. The crying of a woman is not held to betray the same depth of feeling as the sobs of a man; and the petty forms of resentment which belong to what is known as a "shrew," or a "scold," are only to be met with among those daughters of Eve who prove themselves least agreeable to the sons of Adam. Coyness and caprice are very general peculiarities, and we may add, as kindred traits, personal vanity, fondness of display, and delight in the sunshine of admiration. There is also, as compared with the masculine mind, a greater desire for emotional excitement of all kinds, and hence a greater liking for society, pageants, and even for what are called "scenes," provided these are not of a kind to alarm her no less characteristic timidity. Again, in the opinion of Mr. Lecky, with which I partly concur:

> In the courage of endurance they are commonly superior; but their passive courage is not so much fortitude which bears and defies, as resignation which bears and bends. In the ethics of intellect they are decidedly inferior. They very rarely love truth, though they love passionately what they call "the truth," or opinions which they have derived from others, and hate vehemently those who differ from them. They are little capable of impartiality or doubt; their thinking is chiefly a mode of feeling; though very generous in their acts, they are rarely generous in their opinions or in their judgments. They persuade rather than convince, and value belief as a source of consolation rather than as a faithful expression of the reality of things.

But, of course, as expressed in the well-known lines from "Marmion," there is another side to this picture, and, in now taking leave of all these elements of weakness, I must state my honest conviction that they are in chief part due to women as a class not having hitherto enjoyed the same educational advantages as men. Upon this great

question of female education, however, I shall have more to say at the close of this paper, and only allude to the matter at the present stage in order to temper what I feel to be the almost brutal frankness of my remarks.

But now, the meritorious qualities wherein the female mind stands pre-eminent are, affection, sympathy, devotion, self-denial, modesty; long-suffering, or patience under pain, disappointment, and adversity; reverence, veneration, religious feeling, and general morality. In these virtues—which agree pretty closely with those against which the apostle says there is no law—it will be noticed that the gentler predominate over the heroic; and it is observable in this connection that when heroism of any kind is displayed by a woman, the prompting emotions are almost certain to be of an unselfish kind.

All the æsthetic emotions are, as a rule, more strongly marked in women than in men—or, perhaps, I should rather say, they are much more generally present in women. This remark applies especially to the æsthetic emotions which depend upon refinement of perception. Hence feminine "taste" is proverbially good in regard to the smaller matters of every-day life, although it becomes, as a rule, untrustworthy in proportion to the necessity for intellectual judgment. In the arrangement of flowers, the furnishing of rooms, the choice of combinations in apparel, and so forth, we generally find that we may be most safely guided by the taste of women; while in matters of artistic or literary criticism we turn instinctively to the judgment of men.

If we now look in somewhat more detail at the habitual display of these various feelings and virtues on the part of women, we may notice, with regard to affection, that, in a much larger measure than men, they derive pleasure from receiving as well as from bestowing: in both cases affection is felt by them to be, as it were, of more emotional value. The same remark applies to sympathy. It is very rare to find a woman who does not derive consolation from a display of sympathy, whether her sorrow be great or small; while it is by no means an unusual thing to find a man who rejects all offers of the kind with a feeling of active aversion.

Touching devotion, we may note that it is directed by women pretty equally toward inferiors and superiors—spending and being spent in the tending of children; ministering to the poor, the afflicted, and the weak; clinging to husbands, parents, brothers, often without and even against reason.

Again, purity and religion are, as it were, the natural heritage of women in all but the lowest grades of culture. But it is within the limit of Christendom that both these characters are most strongly pronounced; as, indeed, may equally well be said of nearly all the other virtues which we have just been considering. And the reason is that Christianity, while crowning the virtue of chastity with an aureole of mysticism more awful than was ever conceived even by

pagan Rome, likewise threw the vesture of sanctity over all the other virtues which belong by nature to the female mind. Until the rise of Christianity the gentler and domestic virtues were nowhere recognized as at all comparable, in point of ethical merit, with the heroic and the civic. But when the ideal was changed by Christ—when the highest place in the hierarchy of the virtues was assigned to faith, hope, and charity; to piety, patience, and long-suffering; to forgiveness, self-denial, and even self-abasement—we can not wonder that, in so extraordinary a collision between the ideals of virtue, it should have been the women who first flocked in numbers around the standard of the Cross.

So much, then, for the intellect and emotions. Coming lastly to the will, I have already observed that this exercises less control over the emotions in women than in men. We rarely find in women that firm tenacity of purpose and determination to overcome obstacles which is characteristic of what we call a manly mind. When a woman is urged to any prolonged or powerful exercise of volition, the prompting cause is usually to be found in the emotional side of her nature, whereas, in man, we may generally observe that the intellectual is alone sufficient to supply the needed motive. Moreover, even in those lesser displays of volitional activity, which are required in close reading or in studious thought, we may note a similar deficiency. In other words, women are usually less able to concentrate their attention; their minds are more prone to what is called "wandering," and we seldom find that they have specialized their studies or pursuits to the same extent as is usual among men. This comparative weakness of will is further manifested by the frequency among women of what is popularly termed indecision of character. The proverbial fickleness of *la donna mobile* is due quite as much to vacillation of will as to other unstable qualities of mental constitution. The ready firmness of decision which belongs by nature to the truly masculine mind is very rarely to be met with in the feminine; while it is not an unusual thing to find among women indecision of character so habitual and pronounced as to become highly painful to themselves—leading to timidity and diffidence in adopting almost any line of conduct where issues of importance are concerned, and therefore leaving them in the condition, as they graphically express it, of not knowing their own minds.

If, now, we take a general survey of all these mental differences, it becomes apparent that in the feminine type the characteristic virtues, like the characteristic failings, are those which are born of weakness; while in the masculine type the characteristic failings, like the characteristic virtues, are those which are born of strength. Which we are to consider the higher type will therefore depend on the value which we assign to mere force. Under one point of view, the mag-

nificent spider of South America, which is large enough and strong enough to devour a humming-bird, deserves to be regarded as the superior creature. But, under another point of view, there is no spectacle in nature more shockingly repulsive than the slow agonies of the most beautiful of created beings in the hairy limbs of a monster so far beneath it in the sentient as in the zoölogical scale. And although the contrast between man and woman is happily not so pronounced in degree, it is nevertheless a contrast the same in kind. The whole organization of woman is formed on a plan of greater delicacy, and her mental structure is correspondingly more refined: it is further removed from the struggling instincts of the lower animals, and thus more nearly approaches our conception of the spiritual. For even the failings of weakness are less obnoxious than the vices of strength, and I think it is unquestionable that these vices are of quite as frequent occurrence on the part of men as are those failings on the part of women. The hobnailed boots may have given place to patent pumps, and yet but small improvement may have been made upon the overbearing temper of a navvy; the beer-shop may have been superseded by the whist-club, and yet the selfishness of pleasure-seeking may still habitually leave the solitary wife to brood over her lot through the small hours of the morning. Moreover, even when the mental hobnails have been removed, we generally find that there still remains what a member of the fairer sex has recently and aptly designated mental heavy-handedness. By this I understand the clumsy inability of a coarser nature to appreciate the feelings of a finer; and how often such is the case we must leave the sufferers to testify. In short, the vices of strength to which I allude are those which have been born of rivalry: the mental hide has been hardened, and the man carries into his home those qualities of insensibility, self-assertion, and self-seeking which have elsewhere led to success in his struggle for supremacy. Or, as Mr. Darwin says: "Man is the rival of other men; he delights in competition, and this leads to ambition which passes too readily into selfishness. These latter qualities seem to be his natural and unfortunate birthright."

Of course, the greatest type of manhood, or the type wherein our ideal of manliness reaches its highest expression, is where the virtues of strength are purged from its vices. To be strong and yet tender, brave and yet kind, to combine in the same breast the temper of a hero with the sympathy of a maiden—this is to transform the ape and the tiger into what we know ought to constitute the man. And if in actual life we find that such an ideal is but seldom realized, this should make us more lenient in judging the frailties of the opposite sex. These frailties are, for the most part, the natural consequences of our own, and even where such is not the case, we do well to remember, as already observed, that they are less obnoxious than our own, and also that it is the privilege of strength to be tolerant. Now, it is

a practical recognition of these things that leads to chivalry; and even those artificial courtesies which wear the mark of chivalry are of value, as showing what may be termed a conventional acquiescence in the truth that underlies them. This truth is, that the highest type of manhood can only then be reached when the heart and mind have been so far purified from the dross of a brutal ancestry as genuinely to appreciate, to admire, and to reverence the greatness, the beauty, and the strength which have been made perfect in the weakness of womanhood.

I will now pass on to consider the causes which have probably operated in producing all these mental differences between men and women. We have already seen that differences of the same kind occur throughout the whole mammalian series, and therefore we must begin by looking below the conditions of merely human life for the original causes of these differences in their most general form. Nor have we far to seek. The Darwinian principles of selection—both natural and sexual—if ever they have operated in any department of organic nature, must certainly have operated here. Thus, to quote Darwin himself:

Among the half-human progenitors of man, and among savages, there have been struggles between the males during many generations for the possession of the females. But mere bodily strength and size would do little for victory, unless associated with courage, perseverance, and determined energy. . . . To avoid enemies or to attack them with success, to capture wild animals, and to fashion weapons, requires reason, invention, or imagination. . . . These latter faculties, as well as the former, will have been developed in man partly through sexual selection—that is, through the contest of rival males—and partly through natural selection—that is, from success in the general struggle for life; and as in both cases the struggle will have been during maturity, the characters gained will have been transmitted more fully to the male than to the female offspring. . . . Thus man has ultimately become superior to woman. It is, indeed, fortunate that the law of the equal transmission of characters to both sexes prevails with mammals; otherwise it is probable that man would have become as superior in mental endowment to woman as the peacock is in ornamental plumage to the peahen.

Similarly, Mr. Francis Galton writes:

The fundamental and intrinsic differences of character that exist in individuals are well illustrated by those that distinguish the two sexes, and which begin to assert themselves even in the nursery, where all children are treated alike. One notable peculiarity in the woman is that she is capricious and coy, and has less straightforwardness than the man. It is the same with the female of every species. . . . [Were it not so], the drama of courtship, with its prolonged strivings and doubtful success, would be cut quite short, and the race would degenerate through the absence of that sexual selection for which the protracted preliminaries of love-making give opportunity. The willy-nilly disposition of the female is as apparent in the butterfly as in the man, and must have been continually favored from the earliest stages of animal evolution down to the

present time. Coyness and caprice have in consequence become a heritage of the sex, together with a cohort of allied weaknesses and petty deceits, that men have come to think venial, and even amiable, in women, but which they would not tolerate among themselves.

We see, then, that the principles of selection have thus determined greater strength, both of body and mind, on the part of male animals throughout the whole mammalian series; and it would certainly have been a most unaccountable fact if any exception to this rule had occurred in the case of mankind. For, as regards natural selection, it is in the case of mankind that the highest premium has been placed upon the mental faculties—or, in other words, it is here that natural selection has been most busy in the evolution of intelligence—and therefore, as Mr. Darwin remarks, we can only regard it as a fortunate accident of inheritance that there is not now a greater difference between the intelligence of men and of women than we actually find. Again, as regards sexual selection, it is evident that here also the psychologically segregating influences must have been exceptionally strong in the case of our own species, seeing that in all the more advanced stages of civilization—or in the stages where mental evolution is highest, and, therefore, mental differences most pronounced—marriages are determined quite as much with reference to psychical as to physical endowments; and as men always admire in women what they regard as distinctively feminine qualities of mind, while women admire in men the distinctively masculine, sexual selection, by thus acting directly as well as indirectly on the mental qualities of both, is constantly engaged in molding the minds of each upon a different pattern.

Such, then, I take to be the chief, or at least the original, causes of the mental differences in question. But besides these there are sundry other causes all working in the same direction. For example, as the principles of selection have everywhere operated in the direction of endowing the weaker partner with that kind of physical beauty which comes from slenderness and grace, it follows that there has been everywhere a general tendency to impart to her a comparative refinement of organization; and in no species has this been the case in so high a degree as in man. Now, it is evident from what has been said in an earlier part of this paper, that general refinement of this kind indirectly affects the mind in many ways. Again, as regards the analogous, though coarser, distinction of bodily strength, it is equally evident that their comparative inferiority in this respect, while itself one of the results of selection, becomes in turn the cause of their comparative timidity, sense of dependence, and distrust of their own powers on the part of women, considered as a class. Hence, also, their comparative feebleness of will and vacillation of purpose: they are always dimly conscious of lacking the muscular strength which, in the last resort, and especially in primitive stages of culture, is the measure of executive capacity. Hence, also, their resort to petty arts and pretty ways

for the securing of their aims; and hence, in large measure, their strongly religious bias. The masculine character, being accustomed to rely upon its own strength, is self-central and self-contained: to it the need of external aid, even of a supernatural kind, is not felt to be so urgent as it is to the feminine character, whose only hope is in the stronger arm of another. "The position of man is to stand, of woman to lean"; and although it may be hard for even a manly nature to contemplate the mystery of life and the approach of death with a really Stoic calm, at least this is not so impossible as it is for the more shrinking and emotional nature of a woman. Lastly, from her abiding sense of weakness and consequent dependence, there also arises in woman that deeply-rooted desire to please the opposite sex which, beginning in the terror of a slave, has ended in the devotion of a wife.

We must next observe another psychological lever of enormous power in severing the mental structures of men and women. Alike in expanding all the tender emotions, in calling up from the deepest fountains of feeling the flow of purest affection, in imposing the duties of rigid self-denial, in arousing under its strongest form the consciousness of protecting the utterly weak and helpless consigned by Nature to her charge, the maternal instincts are to woman perhaps the strongest of all influences in the determination of character. And their influence in this respect continues to operate long after the child has ceased to be an infant. Constant association with her growing children—round all of whom her affections are closely twined, and in all of whom the purest emotions of humanity are as yet untouched by intellect—imparts to the mother a fullness of emotional life, the whole quality of which is distinctively feminine. It has been well remarked by Mr. Fiske that the prolonged period of infancy and childhood in the human species must from the first "have gradually tended to strengthen the relations of the children to the mother," and, we may add, also to strengthen the relations of the mother to the children—which implies an immense impetus to the growth in her of all the altruistic feelings most distinctive of woman. Thus, in accordance with the general law of inheritance as limited by sex, we can understand how these influences became, in successive generations, cumulative; while in the fondness of little girls for dolls we may note a somewhat interesting example in psychology of the law of inheritance at earlier periods of life, which Mr. Darwin has shown to be so prevalent in the case of bodily structures throughout the animal kingdom.

There remains, so far as I can see, but one other cause which can be assigned of the mental differences between men and women. This cause is education. Using the term in its largest sense, we may say that in all stages of culture the education of women has differed widely from that of men. The state of abject slavery to which woman is consigned in the lower levels of human evolution clearly tends to dwarf her mind *ab initio*. And as woman gradually emerges from this her

primitive and long-protracted condition of slavery, she still continues to be dominated by the man in numberless ways, which, although of a less brutal kind, are scarcely less effectual as mentally dwarfing influences. The stunting tendency upon the female mind of all polygamous institutions is notorious, and even in monogamous or *quasi*-monogamous communities so highly civilized as ancient Greece and pagan Rome, woman was still, as it were, an intellectual cipher—and this at a time when the intellect of man had attained an eminence which has never been equaled. Again, for a period of about two thousand years after that time civilized woman was the victim of what I may term the ideal of domestic utility—a state of matters which still continues in some of the Continental nations of Europe. Lastly, even when woman began to escape from this ideal of domestic utility, it was only to fall a victim to the scarcely less deleterious ideal of ornamentalism. Thus Sydney Smith, writing in 1810, remarks: "A century ago the prevailing taste in female education was for housewifery; now it is for accomplishments. The object now is to make women artists—to give them an excellence in drawing, music, and dancing." It is almost needless to remark that this is still the prevailing taste; the ideal of female education still largely prevalent in the upper classes is not that of mental furnishing, but rather of mental decoration. For it was not until the middle of the present century that the first attempt was made to provide for the higher education of women, by the establishment of Queen's College and Bedford College in London. Twenty years later there followed Girton and Newnham at Cambridge; later still Lady Margaret and Somerville at Oxford, the foundation of the Girls' Public Day-Schools Company, the opening of degrees to women at the University of London, and of the honor examinations at Cambridge and Oxford.

We see, then, that with advancing civilization the theoretical equality of the sexes becomes more and more a matter of general recognition, but that the natural inequality continues to be forced upon the observation of the public mind; and chiefly on this account—although doubtless also on account of traditional usage—the education of women continues to be, as a general rule, widely different from that of men. And this difference is not merely in the positive direction of laying greater stress on psychological embellishment: it extends also in the negative direction of sheltering the female mind from all those influences of a striving and struggling kind, which constitute the practical schooling of the male intellect. Woman is still regarded by public opinion all the world over as a psychological plant of tender growth, which needs to be protected from the ruder blasts of social life in the conservatories of civilization. And, from what has been said in the earlier part of this paper, it will be apparent that in this practical judgment I believe public opinion to be right. I am, of course, aware that there is a small section of the public—composed for the most part of persons who are

not accustomed to the philosophical analysis of facts—which argues that the conspicuous absence of women in the field of intellectual work is due to the artificial restraints imposed upon them by all the traditional forms of education; that if we could suddenly make a leap of progress in this respect, and allow women everywhere to compete on fair and equal terms with men, then, under these altered circumstances of social life, women would prove themselves the intellectual compeers of man.

But the answer to this argument is almost painfully obvious. Although it is usually a matter of much difficulty to distinguish between nature and nurture, or between the results of inborn faculty and those of acquired knowledge, in the present instance no such difficulty obtains. Without again recurring to the anatomical and physiological considerations which bar *a priori* any argument for the natural equality of the sexes, and without remarking that the human female would but illustrate her own deficiency of rational development by supposing that any exception to the general laws of evolution can have been made in her favor—without dwelling on any such antecedent considerations, it is enough to repeat that in many departments of intellectual work the field *has* been open, and equally open, to both sexes. If to this it is answered that the traditional usages of education lead to a higher average of culture among men, thus furnishing them with a better vantage-ground for the origin of individual genius, we have only to add that the strong passion of genius is not to be restrained, by any such minor accidents of environment. Women by tens of thousands have enjoyed better educational as well as better social advantages than a Burns, a Keats, or a Faraday; and yet we have neither heard their voices nor seen their work.

If, again, to this it be rejoined that the female mind has been unjustly dealt with in the past, and can not now be expected all at once to throw off the accumulated disabilities of ages—that the long course of shameful neglect to which the selfishness of man has subjected the culture of woman, has necessarily left its mark upon the hereditary constitution of her mind—if this consideration be adduced, it obviously does not tend to prove the equality of the sexes; it merely accentuates the fact of inequality by indicating one of its causes. The treatment of women in the past may have been very wrong, very shameful, and very much to be regretted by the present advocates of women's rights; but proof of the ethical quality of this fact does not get rid of the fact itself, any more than a proof of the criminal nature of assassination can avail to restore to life a murdered man. We must look the facts in the face. How long it may take the woman of the future to recover the ground which has been lost in the psychological race by the woman of the past, it is impossible to say; but we may predict with confidence that, even under the most favorable conditions as to culture, and even supposing the mind of man to remain stationary (and

not, as is probable, to advance with a speed relatively accelerated by the momentum of its already acquired velocity), it must take many centuries for heredity to produce the missing five ounces of the female brain.

In conclusion, a few words may be added on the question of female education as this actually stands at the present time. Among all the features of progress which will cause the present century to be regarded by posterity as beyond comparison the most remarkable epoch in the history of our race, I believe that inauguration of the so-called woman's movement in our own generation, will be considered one of the most important. For I am persuaded that this movement is destined to grow ; that with its growth the highest attributes of one half of the human race are destined to be widely influenced ; that this influence will profoundly react upon the other half, not alone in the nursery and the drawing-room, but also in the study, the academy, the forum, and the senate ; that this latest yet inevitable wave of mental evolution can not be stayed until it has changed the whole aspect of civilization. In an essay already alluded to, Sydney Smith has remarked, though not quite correctly, that up to his time there had been no woman who had produced a single notable work, either of reason or imagination, whether in English, French, German, or Italian literature. A few weeks ago Mrs. Fawcett was able to show us that since then there have been at least forty women who have left a permanent mark in English literature alone. Now this fact becomes one of great significance when we remember that it is the result of but the earliest phase of the woman's movement. For, as already indicated, this movement is now plainly of the nature of a ferment. When I was at Cambridge, the then newly-established foundations of Girton and Newnham were to nearly all of us matters of amusement. But we have lived to alter our views ; for we have lived to see that that was but the beginning of a great social change, which has since spread, and is still spreading, at so extraordinary a rate that we are now within measurable distance of the time when no English lady will be found to have escaped its influence. It is not merely that women's colleges are springing up like mushrooms in all quarters of the kingdom, or that the old type of young ladies' governess is being rapidly starved out of existence. It is of much more importance even than this that the immense reform in girls' education, which has been so recently introduced by the Day-Schools Company working in conjunction with the University Board and local examinations, has already shaken to its base the whole system, and even the whole ideal, of female education, so that there is scarcely a private school in the country which has not been more or less affected by the change. In a word, whether we like it or not, the woman's movement is upon us ; and what we have now to do is to guide the flood into what

seem likely to prove the most beneficial channels. What are these channels?

Of all the pricks against which it is hard to kick, the hardest are those which are presented by Nature in the form of facts. Therefore we may begin by wholly disregarding those short-sighted enthusiasts who seek to overcome the natural and fundamental distinction of sex. No amount of female education can ever do this, nor is it desirable that it should. On this point I need not repeat what is now so often and so truly said, as to woman being the complement, not the rival, of man. But I should like to make one remark of another kind. The idea underlying the utterances of all these enthusiasts seems to be that the qualities wherein the male mind excels that of the female are, *sui generis*, the most exalted of human faculties: these good ladies fret and fume in a kind of jealousy that the minds, like the bodies, of men are stronger than those of women. Now, is not this a radically mistaken view? Mere strength, as I have already endeavored to insinuate, is not the highest criterion of nobility. Human nature is a very complex thing, and among the many ingredients which go to make the greatness of it even intellectual power is but one, and not by any means the chief. The truest grandeur of that nature is revealed by that nature as a whole, and here I think there can be no doubt that the feminine type is fully equal to the masculine, if indeed it be not superior. For I believe that if we all go back in our memories to seek for the highest experience we have severally had in this respect, the character which will stand out as all in all the greatest we have ever known, will be the character of a woman. Or, if any of us have not been fortunate in this matter, where in fiction or in real life can we find a more glorious exhibition of all that is best—the mingled strength and beauty, tact, gayety, devotion, wit, and consummate ability—where but in a woman can we find anything at once so tender, so noble, so lovable, and so altogether splendid as in the completely natural character of a Portia? A mere blue-stocking, who looks with envy on the intellectual gifts of a Voltaire, while shutting her eyes to the gifts of a sister such as this, is simply unworthy of having such a sister: she is incapable of distinguishing the pearl of great price among the sundry other jewels of our common humanity.

Now, the suspicion, not to say the active hostility, with which the so-called woman's movement has been met in many quarters, springs from a not unhealthy ground of public opinion. For there can be no real doubt that these things are but an expression of the value which that feeling attaches to all which is held distinctive of feminine character as it stands. Woman, as she has been bequeathed to us by the many and complex influences of the past, is recognized as too precious an inheritance lightly to be tampered with; and the dread lest any change in the conditions which have given us this inheritance should lead, as it were, to desecration, is in itself both wise and worthy. In

this feeling we have the true safeguard of womanhood; and we can hope for nothing better than that the deep, strong voice of social opinion will always be raised against any innovations of culture which may tend to spoil the sweetest efflorescence of evolution.

But, while we may hope that social opinion may ever continue opposed to the woman's movement in its most extravagant forms—or to those forms which endeavor to set up an unnatural, and therefore an impossible, rivalry with men in the struggles of practical life—we may also hope that social opinion will soon become unanimous in its encouragement of the higher education of women. Of the distinctively feminine qualities of mind which are admired as such by all, ignorance is certainly not one. Therefore learning, as learning, can never tend to deteriorate those qualities. On the contrary, it can only tend to refine the already refined, to beautify the already beautiful—"when our daughters shall be as corner-stones, polished after the similitude of a palace." It can only tend the better to equip a wife as the helpmeet of her husband, and by furthering a community of tastes, to weave another bond in the companionship of life. It can only tend the better to prepare a mother for the greatest of her duties—forming the tastes and guiding the minds of her children at a time when these are most pliable, and under circumstances of influence such as can never again be reproduced.

It is nearly eighty years ago since this view of the matter was thus presented to Sydney Smith:

> If you educate women to attend to dignified and important subjects, you are multiplying beyond measure the chances of human improvement by preparing and medicating those early impressions which always come from the mother, and which, in the majority of instances, are quite decisive of genius. The instruction of women improves the stock of national talents, and employs more minds for the instruction and improvement of the world: it increases the pleasures of society by multiplying the topics upon which the two sexes take a common interest, and makes marriage an intercourse of understanding as well as of affection. The education of women favors public morals; it provides for every season of life, and leaves a woman when she is stricken by the hand of Time, not as she now is, destitute of everything and neglected by all, but with the full power and the splendid attractions of knowledge—diffusing the elegance of polite literature, and receiving the homage of learned and accomplished men.

Since the days when this was written, the experiment of thus educating women to attend to dignified and important subjects has been tried on a scale of rapidly-increasing magnitude, and the result has been to show that those apprehensions of public opinion were groundless which supposed that the effect of higher education upon women would be to deteriorate the highest qualities of womanhood. On this point I think it is sufficient to quote the opinion of a lady who has watched the whole course of this experiment, and who is so well qualified to give an opinion that it would be foolish presumption in any

one else to dispute what she has to say. The lady to whom I refer is Mrs. Sidgwick, and this is what she says:

> The students that I have known have shown no inclination to adopt masculine sentiments or habits in any unnecessary or unseemly degree; they are disposed to imitate the methods of life and work of industrious undergraduates just as far as these appear to be means approved by experience to the end which both sets of students have in common, and nothing that I have seen of them, either at the university or afterward, has tended in the smallest degree to support the view that the adaptation of women to domestic life is so artificial and conventional a thing that a few years of free, unhampered study and varied companionship at the university has a tendency to impair it.

So far as I am aware, only one other argument has been, or can be, adduced on the opposite side. This argument is that the physique of young women as a class is not sufficiently robust to stand the strain of severe study, and therefore that many are likely to impair their health more or less seriously under the protracted effort and acute excitement which are necessarily incidental to our system of school and university examinations. Now, I may begin by remarking that with this argument I am in the fullest possible sympathy. Indeed, so much is this the case that I have taken the trouble to collect evidence from young girls of my own acquaintance who are now studying at various high-schools with a view to subsequently competing for first classes in the Cambridge triposes. What I have found is that in some of these high-schools—carefully observe, only in *some*—absolutely no check is put upon the ambition of young girls to distinguish themselves and to bring credit upon their establishments. The consequence is that in these schools the more promising pupils habitually undertake an amount of intellectual work which it is sheer madness to attempt. A single quotation from one of my correspondents—whom I have known from a child—will be enough to prove this statement:

> I never begin work later than six o'clock, and never work less than ten or eleven hours a day. But within a fortnight or so of my examinations I work fifteen or sixteen hours. Most girls, however, stop at fourteen or fifteen hours, but some of them go on to eighteen hours. Of course, according to the school time-tables, none of us should work more than eight hours; but it is quite impossible for any one to get through the work in that time. For instance, in the time-tables ten minutes is put down for botany, whereas it takes the quickest girl an hour and a half to answer the questions set by the school lecturer.

These facts speak for themselves, and therefore I will only add that in many of those high-schools for girls which are situated in large towns no adequate provision is made for bodily exercise, and this, of course, greatly aggravates the danger of overwork. In such a school there is probably no play-ground; the gymnasium, if there is one, is not attended by any of the harder students; drill is never thought of; and the only walking exercise is to and from the school. Let it not be supposed that I am attacking the high-school system.

On the contrary, I believe that this system represents the greatest single reform that has ever been made in the way of education. I am only pointing out certain grave abuses of the system which are to be met with in some of these schools, and against which I should like to see the full force of public opinion directed. There is no public school in the kingdom where a boy of sixteen would be permitted to work from eleven to eighteen hours a day, with no other exercise than a few minutes' walk. Is it not, then, simply monstrous that a girl should be allowed to do so? I must confess that I have met with wonderfully few cases of serious breakdown. All my informants tell me that, even under the operation of so insane an abuse as I have quoted, grave impairment of health but rarely occurs. This, however, only goes to show of what good stuff our English girls are made; and therefore may be taken to furnish about the strongest answer I can give to the argument which I am considering—viz., that the strength of an average English girl is not to be trusted for sustaining any reasonable amount of intellectual work. Upon this point, however, there is at the present time a conflict of medical authority, and, as I have no space to give a number of quotations, it must suffice to make a few general remarks.

In the first place, the question is one of fact, and must therefore be answered by the results of the large and numerous experiments which are now in progress; not by any *a priori* reasoning of a physiological kind. In the next place, even as thus limited, the inquiry must take account of the wisdom or unwisdom with which female education is pursued in the particular cases investigated. As already remarked, I have been myself astonished to find so great an amount of prolonged endurance exhibited by young girls who are allowed to work at unreasonable pressure; but, all the same, I should of course regard statistics drawn from such cases as manifestly unfair. And seeing that every case of health impaired is another occasion given to the enemies of female education, those who have the interests of such education at heart should before all things see to it that the teaching of girls be conducted with the most scrupulous precautions against over-pressure. Regarded merely as a matter of policy, it is at the present moment of far more importance that girls should not be over-strained than that they should prove themselves equal to young men in the class lists. For my own part, I believe that, with reasonable precautions against over-pressure, and with due provision for bodily exercise, the higher education of women would *ipso facto* silence the voice of medical opposition. But I am equally persuaded that this can never be the case until it becomes a matter of general recognition among those to whom such education is intrusted, that no girl should ever be allowed to work more than eight hours a day as a *maximum;* that even this will in a large proportional number of cases be found to prove excessive; that without abundant exercise higher education

should never be attempted; and that, as a girl is more liable than a boy to insidiously undermine her constitution, every girl who aspires to any distinction in the way of learning should be warned to be constantly on the watch for the earliest symptoms of impairment. If these reasonable precautions were to become as universal in the observance as they now are in the breach, I believe it would soon stand upon the unquestionable evidence of experimental proof, that there is no reason in the nature of things why women should not admit of culture as wide and deep and thorough as our schools and universities are able to provide.

The channels, therefore, into which I should like to see the higher education of women directed are not those which run straight athwart the mental differences between men and women which we have been considering. These differences are all complementary to one another, fitly and beautifully joined together in the social organism. If we attempt to disregard them, or try artifically to make of woman an unnatural copy of man, we are certain to fail, and to turn out as our result a sorry and disappointed creature who is neither the one thing nor the other. But if, without expecting women as a class to enter into any professional or otherwise foolish rivalry with men, for which as a class they are neither physically nor mentally fitted, and if, as Mrs. Lynn Linton remarks, we do not make the mistake of confusing mental development with intellectual specialization—if, without doing either of these things, we encourage women in every way to obtain for themselves the intrinsic advantages of learning, it is as certain as anything can well be that posterity will bless us for our pains. For then all may equally enjoy the privilege of a real acquaintance with letters; ladies need no longer be shut out from a solid understanding of music or painting; lecturers on science will no longer be asked at the close of their lectures whether the cerebellum is inside or outside of the skull, how is it that astronomers have been able to find out the names of the stars, or whether one does not think that his diagram of a jelly-fish serves with admirable fidelity to illustrate the movements of the solar system. These, of course, I quote as extreme cases, and even as displaying the prettiness which belongs to a child-like simplicity. But simplicity of this kind ought to be put away with other childish things; and in whatever measure it is allowed to continue after childhood is over, the human being has failed to grasp the full privileges of human life. Therefore, in my opinion, the days are past when any enlightened man ought seriously to suppose that in now again reaching forth her hand to eat of the tree of knowledge, woman is preparing for the human race a second fall. In the person of her admirable representative, Mrs. Fawcett, she thus pleads: "No one of those who care most for the woman's movement cares one jot to prove or to maintain that men's brains and women's brains are exactly alike or exactly equal. All we ask is that the social and legal status of women should be such

as to foster, not to suppress, any gift for art, literature, learning, or goodness with which woman may be endowed." Then, I say, give her the apple, and see what comes of it. Unless I am greatly mistaken, the result will be that which is so philosophically as well as so poetically portrayed by the Laureate:

"The woman's cause is man's: they rise or sink
Together, dwarfed or godlike, bond or free.

. . . . . .

"Then let her make herself her own
To give or keep, to live and learn to be
All that not harms distinctive womanhood.
For woman is not undeveloped man,
But diverse: could we make her as the man,
Sweet Love were slain: his dearest bond is this,
Not like to like, but like in difference.

"Yet in the long years liker must they grow;
The man be more of woman, she of man;
He gain in sweetness and in moral height,
Nor lose the wrestling thews that throw the world;
She mental breadth, nor fail in childward care,
Nor lose the child-like in the larger mind;
Till at the last she set herself to man,
Like perfect music unto noble words.

. . . . . .

"Then comes the statelier Eden back to men:
Then reign the world's great bridals, chaste and calm:
Then springs the crowning race of human kind.
May these things be!"

—*Nineteenth Century.*

MODERN OVER-EDUCATION.

THE appeal made by Professor Jowett, in the columns of the "Times," for state aid to provincial colleges established to promote "higher education," naturally raises the question how high education for the bulk of mankind ought to go. The world has heard something too much of the subject of late years, and the theme has been worn rather threadbare. Every lecturer in want of a topic, every Radical member of Parliament, bound to deliver an address to his constituents, and having exhausted his wrath against the House of Lords and the landed interest and his ideas on the Irish question, finds an unfailing resource in discoursing on education, in which he may deliver himself of platitudes *ad libitum*, and raise an approving cheer by informing his audience for the fiftieth time that "knowledge is power." It has ever been a boon to the Socialists and other democrats, who have discovered in their scheme of free education a convenient means of drawing upon the income of one class for the benefit of another. School

boards make continually increasing demands upon the property of the rich, and, in the true spirit of all Liberal legislation, tyrannically encroach upon the liberties of the poor. Cramming and competition, standards and examinations, are being multiplied to such an extent that they occupy a large portion of human life, which is becoming a scene of probation indeed, in a sense in which the phrase was never before used. At this rate of progress we seem likely soon to arrive at the educational absurdity which prevails in the Chinese Empire, where an official in his ninetieth year has recently passed his "final examination," which places him on the pinnacle of Chinese wisdom and enrolls him in the most exalted rank of mandarins, a sublime elevation which the lengthened period of study it has taken to acquire it has left him little time to enjoy.

But, in spite of all this clamor, it is open to question whether the present rising generation are well educated, or even educated, in the original and natural sense of the word, at all. The Latin word *educo*, from which our English word is derived, means simply to draw out or train. To strengthen the faculties, to sharpen the intelligence, and to form the character—are any of these objects attained, or even aimed at, in modern education? Practically only one faculty—memory—is cultivated at the expense of all the rest, and that is overburdened. The impossible is attempted, and the young mind strained and exhausted, rather than strengthened, in the desperate effort to acquire a superficial acquaintance with almost every form of human knowledge, in order to answer the catch-questions of an examiner, who would be baffled by his own wisdom if he had not the resource of referring, when his memory fails him, to his notes or his books. A boy has now no time to digest and assimilate what he acquires, nor has he any encouragement to do so. He must "think nothing gained while aught remains," and push on to new conquests until either the dreaded day of examination arrives, or his health breaks down, and renders him unfit to be examined, or perhaps unequal to any occupation at all. The simple course of education of the ancient Persians, to ride, to draw the bow, and to speak the truth, had its advantages as compared with the modern system. Of course, in these days it is not possible to be satisfied with so limited a curriculum, though the native virtue of speaking the truth might with advantage be cultivated much more diligently than it is, more especially by some of our public men, who, by-the-way, are the real teachers, for they it is who complete the education of men who in their turn teach the youth. But some approach might be made to the simplicity of the Greek system, which, based upon the truism that it is impossible to overstrain the mind in a healthy body, in full exercise, seems to have been directed chiefly to strengthening the frame and the mental powers without exhausting either, cultivating a taste for study, and to acquiring the arts of rhetoric and elocution. For most men at the present day this is

enough ; an exception, of course, must be made of those who are intended for a learned profession, and especially of those whose life is to be spent in instructing others. Clergymen and schoolmasters must be well instructed, or they can not teach. A certain number of scholars and men of science are necessary, but it is not necessary that any of us should attempt the acquisition of universal knowledge. It is not possible, nor desirable, if it were possible, that all should become Bentleys or Porsons. Education does enough if it puts into the hands of youth the key of knowledge, and teaches how to use it. It does too much if it exhausts the brain, and burdens the memory with an immense number of facts which can not be permanently retained with sufficient accuracy to be useful, and which as frequently dwarf as enlarge the intellect by checking its tendency to originate. The creative faculties of the mind are its noblest part, and what encouragement to them is given by the system of modern education? An original opinion expressed in an essay may run counter to the prejudices and hurt the feelings of the examiner, who promptly revenges himself by depriving the examinee of the marks to which he is fairly entitled. This is no imaginary case, but it can be corroborated by many an unlucky victim of this Chinese system, who has not comprehended that we have imported with it the Celestial habit of close imitation, and that we must now not only read but think in a groove, and follow, as closely as we are able to discover them, the peculiarities of the examiner's mind, after the manner of the Chinese tailor who, being directed to make a European coat on the model of an old one supplied to him, reproduced it in *fac-simile*, patches and all. Fortunately, most of these professors have written books ; it is, therefore, in most cases easy enough to win their good graces by a slavish imitation, which is said to be the most delicate and seductive kind of flattery. Thus both are ingeniously demoralized, and learning certainly is not advanced. But are not the advantages of education, even of the best, greatly overrated? One spark of genius is worth all that was ever taught in schools. Who are the men who have enlightened and transformed the world? Certainly not the most highly educated. It might almost be maintained that those who have done most have learned least from others. Alexander the Great, indeed, was highly educated for his time, but, as he began active life at sixteen, when he commanded a wing of his father's army at the battle of Chæronea, he had not leisure to acquire much ; and it may safely be affirmed that it was not the precepts of Aristotle which showed him how to overthrow the Persian Empire, and leave a name which will be remembered as long as the world shall last. His acute intellect, his daring spirit, his boundless ambition, resistless and untiring energy, and his iron will were his instructors, and made him the master of the world. "Sweetest Shakespeare, Fancy's child," did not acquire the power to warble "his native wood-notes wild" at the village school, which yet prepared

him sufficiently to enable him to display his genius. Newton as a boy was averse to study, and though he took a degree at Cambridge, it was not that of senior wrangler, yet what mathematician has equaled him in reputation, or in the importance of his discoveries? Watt, the inventor of the steam-engine, and Whitworth, who made the tools by the use of which it has been brought to its present perfection, were both self-taught. The same may be said of Arkwright, and almost every discoverer who has been a real public benefactor. In the loftier ranks of the leaders of mankind education has never played an important part. Cromwell's youth was passed in idleness and obscurity; he had no instruction even in the military art, in which he had no rival in his day.

Lord Beaconsfield was never at a public school, nor passed through a university, and all the education he ever received appears to have been what would now be thought merely rudimentary, but it was enough for him. His stores of knowledge must have been acquired only by reading; but this armory, in his skillful hands, provided him with weapons quite adequate to an encounter with even his most formidable adversaries. The world is not governed, or even perceptibly influenced, by professors or Admirable Crichtons. It is ruled by men of action. The daring genius of Clive did more for England, and even for the advancement of the human race, by establishing that Pax-Britannica, under which 140,000,000 human beings now enjoy protection and prosperity, than all the learning of the schools. . . . The only education worthy of the name is that which, by hardening and invigorating the frame, lays the foundation of health of body and mind, which forms the character, imparts sufficient knowledge to enable each individual to cultivate the special taste which Nature has given him, and, instead of teaching only the art of passing examinations, endeavors to inspire all with the solid virtues of courage, self-reliance, honor, and religion, and makes a living, thinking, acting being, full of resource, spirit, and energy, not a walking encyclopædia—in one word, a man, and not a "professor."—*Land and Water.*

SKETCH OF ISAAC LEA.

FEW naturalists have enjoyed a longer working-life, or been able to make it more fruitful in finished achievement, than Isaac Lea. His first paper, being a simple account of the minerals then known to exist in the vicinity of Philadelphia, was published in 1818. Additions to this contribution were made but slowly for a few years, but as the list swelled they become frequent, giving evidence of indefatigable industry in research; and the last paper, standing as No. 279 on the catalogue, is dated 1876, closing a record of fifty-eight years of productive activity. During most of this time Dr. Lea was associated

in the conduct of a large publishing-house, and was only able to give his hours of leisure to science.

Isaac Lea was born in Wilmington, Delaware, March 4, 1792. He was descended from ancestors who came over from Gloucestershire, England, with William Penn, and were described as "a couple of noted and valued preachers." He was the fifth son of James Lea, a wholesale merchant, and was at first put in a course of classical instruction at the academy in Wilmington, in preparation for the medical profession. This purpose was afterward given up, and, when he was fifteen years old, Isaac was sent to Philadelphia to engage in mercantile business in association with his brother. He had inherited a strong taste for Nature from his mother, and found a congenial spirit in Professor Vanuxem, then also a youth, with whom he formed the habit of making collecting excursions around the city. The two companions were soon led, by what they found and observed, to inquiry into the composition and structure of the rocks; they had to pursue it at first without any guidance, but in a short time became acquainted with the mineralogical collection of Dr. Adam Seybert. A diversion to their pursuits was given by the occurrence of the war with Great Britain in 1812. They joined a volunteer rifle company, which offered its services to the Governor. Although the company was disbanded without being called into service, young Lea had, by joining it, engaged enough in war to violate the principles of the Society of Friends, and he lost his birthright in it. Among the excursions which the two youths made was one to the coal-mines near Wilkesbarre, where they found slates containing mollusca, which Lea described forty years afterward in the "Journal of the Academy of Natural Sciences." They walked back, over the Pocono Mountain through the Wind-Gap, where Lea found the first trilobite they had ever seen, and down the Delaware River. In 1815 they were both elected members of the Philadelphia Academy of Natural Sciences, and began to take active parts in its proceedings; and in this society Mr. Lea read his first paper, already referred to, embodying the results of many years of close observation which the friends had made upon the rocks during their excursions.

On the publication, in 1818, of Professor Silliman's prospectus of the "American Journal of Science," Mr. Lea procured the names of fourteen subscribers to the journal—an act which Professor Silliman afterward declared "was the turning-point of the scheme"; for, receiving such encouragement from a person with whom he had no personal acquaintance, he was sure the journal would be successful. Mr. Lea contributed several papers to the early numbers of this journal, at the editor's request; but the article of this period which is perhaps most worthy of special mention, is one that he published in 1828 in the "American Quarterly Review," on the Northwest Passage, in which he expressed the opinion that, if the passage were ever made, it must be, as was indicated by the direction of the currents, from west to

east. This hypothesis was verified in 1852 by Captain McClure's making the passage in the direction described.

As Mr. Lea advanced in his geological studies, he found that it was necessary to know something of shells. In order to study their genera as described by Lamarck, he imported a large collection of shells from China. He soon became interested in this branch of the science, and ultimately made it the leading object of his researches. A collection of several species of *Unio*, including some beautiful and rare specimens, was sent to the Academy of Natural Sciences, in 1825, by Major Long, of the Engineer Corps, who had obtained them in dredging the channel of the Ohio River below Louisville. At about the same time, Mr. Lea's brother Thomas, having engaged to look after the shells in the vicinity of Cincinnati, where he was living, shipped a barrel of shells of rare beauty, including six new species. The description of these specimens—"Description of Six New Specimens of the Genus Unio"—presented to the American Philosphical Society in 1827, formed the first of that long series of papers on the *Unio* and allied shells which constitute the chief of Mr. Lea's works. Yet, at the time he presented it, he had no thought that he should ever have another word to say on the subject, for at that time no one conceived the infinite variety of species of the family which American waters are now known to contain. As a side-result of Mr. Lea's interest in the *Unios* may be mentioned the conversion of his brother from an indifferent barreler of shells for another to an enthusiastic student of land-shells and botany, and to be the author of a monograph on "The Plants of Cincinnati."

Dr. Lea spent the traveling season of 1832 in Europe, where the journal of his excursions is a record of successive introductions to famous scientific men, and interesting conversations with them, in which he was never the only one who received information. In London he attended a meeting of the Geological Society, and met most of the leading geologists of Great Britain. At Oxford, he attended the second meeting of the British Association, over which Dr. Buckland presided. Meeting Dr. Buckland afterward in London, the conversation turned upon the quantity of coal in the United States. Dr. Buckland thought we had very little coal. Dr. Lea pointed out on a map the coal-fields of the United States as they were then known. After several hours spent in the examination of the matter, Dr. Buckland taking notes all the time, the distinguished geologist remarked, as he took his leave to meet an engagement, that England had enough coal to supply the United States when its supply should fail. Dr. Lea replied that the quantity of anthracite and bituminous coal was almost unlimited in North America, and promised to send him maps and sections that would satisfy him upon the subject. He fulfilled his promise after he returned home, and, upon the evidence thus afforded, Dr. Buckland presented a paper to the next meeting of the British Association on the extent of our coal-supply. At the British Museum, by the re-

quest of Dr. Gray, Dr. Lea went over the collection of the *Unionidæ*, arranged and named them correctly, and added some new species from the United States. He called, in Paris, on Baron Ferussac, the eminent student of terrestrial and fluviatile mollusca, who was then engaged in preparing his great work on the *Unionidæ*. During the conversation the baron "complimented Dr. Lea by saying that he could not go on with his work until he (Dr. Lea) had finished his memoirs." Dr. Lea afterward spent several hours in going over the baron's collections, which contained *Unionidæ* from Brazil, Syria, Turkey, and Egypt, and rearranging it, cutting down the species and forming numerous synonyms. Afterward, he met Blainville, Ferussac, and others at the Jardin des Plantes, to arrange and name all the *Unionidæ* of the collection there, to which he added fourteen species. From Studer, the elder, in Berne, he received the last copy in the author's possession of his work on the land and fresh-water shells of Switzerland, and compliments on the papers he had himself written. At Paris, again, he examined the *Unionidæ* in the Duc de Rivoli's collection, which contained all those of Lamarck, and was thereby able to identify all of Lamarck's species in his subsequent memoir. Calling on M. Gay by invitation, he was shown all the mollusca which that naturalist had collected in his travels, and was invited to select a specimen of each. Thus he found the most eminent naturalists everywhere, on the strength of the few papers he had published on American mollusca, ready to welcome him as one of themselves, and to receive instruction from him. Their general message to him was to go on with the investigations he had begun, with the assurance that no naturalist in America or Europe had the advantages that he possessed.

On returning home in November, 1832, he found that he had been anticipated in a work he should have done on the Tertiary shells of Alabama, but, having specimens of the species in his cabinet, he prepared a paper, "Contributions to Geology," which he presented to the Academy of Natural Sciences in August, 1833. It contained two hundred and twenty-one species. His "Synopsis of the Family Naïades," published in 1836, and afterward supplemented and expanded, is said to have settled satisfactorily to most conchologists the synonymy of the species. On receiving it, Prince Charles Bonaparte expressed a desire to see all parts of zoölogy treated in the same manner. In 1849 Dr. Lea presented a paper on the foot-marks of the reptile *Sauropus primævus*, found by him in the red shales at Pottsville, Pennsylvania, seventeen hundred feet below the conglomerate, which was of interest on account of the discussion it excited as to the age of the fossil. The foot-prints were assigned to the old red sandstone, while Professor Agassiz had declared that he did not believe that any air-breathing animals had existed before the new red sandstone. The discussion was kept up for several years, in the course of which Dr. Lea reiterated and maintained his position that the fossil was what he

represented it, and that the formation in which it was found was the one indicated by Rogers as No. XI. Its interest has since been diminished by the discovery and authentication of fossils of air-breathers in still older formations. Another series of papers of peculiar interest was that concerning the fossil saurian of the new red sandstone (*Clepsysaurus Pennsylvanicus*).

Having retired from business in 1851, Dr. Lea made another visit to Europe in 1852. Many of the incidents of his previous visit were substantially repeated, but in large part with naturalists of another generation than those whom he had met before. At Paris he arranged and named the *Unionidæ* in the cabinets of the eminent conchologists Boivin and Petit. He called upon Dr. Chenu to look for the original specimen of *Mulleria* of Ferussac, which had never been figured, but simply described as being in Lamarck's collection. "He told Dr. Chenu that he thought it must have been mixed with the *Etheria*, of which the collection had many specimens. Dr. Chenu declared this could not be so, or he would have seen it. As soon as he pulled out the drawer, Dr. Lea saw at a glance the identical specimen which Ferussac had described. He took it up and declared this to be it. Both the naturalists were surprised and delighted. . . . Thus Dr. Lea's theory of the genus *Acostea*, of D'Orbigny, was complete—it was a *Mulleria*." At Vienna he showed the Austrian naturalists some features in their species and specimens which had escaped their eyes. At Berlin he found Humboldt and other distinguished men of science much interested in what was going on in geology in the United States. At a dinner with the Philosophical Club in London, Sir Charles Lyell gave him credit for being the first and only one who had yet observed an air-breathing animal in so ancient a rock as that in which the *Sauropus primævus* occurred, and added that the *Clepsysaurus Pennsylvanicus* was the first discovery of bones in the new red sandstone, although a jaw of a similar animal had since been found. Colonel Sabine exhibited a bottle which he supposed had come through Behring Strait from Japan, which Dr. Lea was able to claim as a verification of his theory of a west-to-east Arctic current.

On his return home in November, 1853, Dr. Lea found an accumulation of correspondence and specimens awaiting his attention that hardly diminished, so incessant were the fresh arrivals, during the remainder of his active life, or for twenty-five years. Among his new Southern and Southwestern correspondents was Bishop Elliott, of Georgia, who became greatly interested in the mollusca of that State, and engaged others in interest in the subject and in collecting shells. The scientific researches of Dr. Lea were continued, with constant publications, until 1877, when a sudden illness which came upon him in Southern California disabled him from further vigorous work. He still, however, continued to add to his collections and perform such work upon them as his strength would allow. He gave much attention

to the microscopic examination of quartz-crystals, with drawings and descriptions of the inclusions and markings of each, so that Professor H. Rosenbusch, in his work on the subject, mentioned him as having been the first in America to enter into microscopic mineralogy. He had engaged, since his return from Europe, in other branches of natural history than conchology. The elephant folio edition of the account of the fossil foot-marks near Pottsville elicited warm commendation for the beauty of its execution and illustration. In 1858 appeared a memoir on the embryology of the *Unionidæ*, giving descriptions and figures of thirty-eight species. In all of his papers he described eighteen hundred and seventy-two species of mollusks of various kinds, most of which were from the United States. The series was embodied in a private edition of thirteen volumes, with three indexes, which the author distributed among men of science and learned societies. Richard Owen, acknowledging the receipt of one of the volumes, said, "They represent a kind or class of labors the most genuine and important and lasting, in the hard endeavor to gain a knowledge of Nature." Professor Haidinger, of Vienna, said, on a similar occasion, that his work would "last as long as natural science shall be cultivated by mankind. The more it is compared and studied, the more appears your power of observation, your efforts in pursuing your object, your steadiness and perseverance." M. A. Boivin wrote, "You render a great service to science in devoting your time to the classification and description of the *Unio*." About ten thousand individuals were displayed in Dr. Lea's cabinet of *Unionidæ*, so arranged that each could be separately examined, and, in many instances, with a sequence from the youngest to the oldest, so as to exhibit the aspects of growth. His other cabinets contained nearly a thousand specimens of quartz-crystals, nearly five hundred of corundum, thirty-five drawers of the mica group, and several hundred sections of lamina prepared for the microscope.

In his ninety-fourth year Dr. Lea continued in good health, with his mental and physical faculties unimpaired; and in 1884 he was able to receive and entertain about two hundred members of the British Association at his cottage at Long Branch. He was President of the Academy of Natural Sciences in Philadelphia from 1853 to 1858, and was President of the American Association in 1860. The list given in his "Bibliography" of the society honors conferred upon him numbers twenty-eight titles, and concludes with an etc. A correspondent who maintained most intimate and confidential relations with Dr. Lea for more than twenty years, furnishes a sketch of his personal character and social life, from which we quote the following words:

"Possessing a mind of great vigor and culture, he was a most genial companion to those whose tastes and sympathies accorded with his own. He was an ardent admirer of the works of Nature; and his cultivated mind enabled him to perceive many qualities and properties

in them, the beauties of which are not comprehended by a less gifted observer. Few objects escaped his notice. He possessed, in an eminent degree, a prompt and keen appreciation of the sublime and of the grotesque; and a speedy judgment in detecting merit or fraud, affectation or sincerity.

"Dr. Lea habitually, during a period of nearly half a century, spent many hours of the night in his studies and his writings, seldom relinquishing them before midnight. These night studies were continued, with little intermission, until he was nearly eighty years old; and they were gradually and finally abandoned only in compliance with the warnings of his medical adviser. Until Dr. Lea became enfeebled with age, at a late period in his life, it was a source of great delight to him to collect mineral specimens in Chester and Delaware Counties in Pennsylvania. His most frequent companions, on such occasions, were Mr. William W. Jefferis, formerly of West Chester, and the writer. No ardent school-boy manifested more enthusiasm in digging than he, when a fair prospect was afforded for obtaining specimens; and his well-trained eye quickly recognized a specimen, though covered with soil. He never permitted any person to clean his specimens excepting himself; and that operation he performed with great patience, in the most complete manner, in order to display all the beauties which the minerals possessed. He was familiar with nearly all the mineral localities in Eastern Pennsylvania. Many years ago the writer described a locality for minerals in Delaware County, which he supposed would be new to Dr. Lea, and received the following reply from him: 'I have crawled all over that locality, on my hands and knees, a half-dozen times, with good results every time.'

"Dr. Lea was a strong admirer of gems, and his familiarity with precious stones was so great that he was considered to be one of the best judges of them in this country. He devoted more time than any other mineralogist to the microscopic examination of the precious stones; the results from which were published, at various times, in the proceedings of the Academy of Natural Sciences. He possessed a large collection of precious stones from all the important localities in the world; and copious notes, in his own writing, are still attached to all the specimens.

"During the last few years of Dr. Lea's life, after he relinquished much of the active work in his mineral cabinet, his time was usually spent in his library, in the happy enjoyment of life, surrounded by his books referring to his favorite studies, mineralogy, geology, and conchology. He enjoyed especially the company of his scientific friends, and his interest in discussing scientific subjects was maintained until his final illness."

Another friend of Dr. Lea's expresses surprise that, in all the published notices of him, "no one has spoken of his wonderful powers of observation of Nature even in her minutest forms. You will pardon

me if I say that I consider it one of his highest qualifications as a man of science. Nothing ever escaped his quick eye in the field or by the road-side when driving. Every tree, shrub, and flower, was full of interest to him, from which he ever imparted knowledge to his friends. In observing crystalline forms I believe he excelled others."

Another friend regards him from a different point of view, and says: "Something of his great-heartedness was revealed to even the casual observer. It found expression in form, and feature, and voice. Yet it was by those who knew him intimately that the social, affectional qualities of his nature were best perceived and most admired. Inheriting a loving spirit, and receiving the gentle impressions of a Christian home, he never lost his priceless dower. The demands of successful, enlarging business, the fondness for scientific study, the passion for scientific discovery, the allurements of fame, were wholly insufficient to make him other than amiable and self-forgetful. His home was the source and center of his delight. He gratefully acknowledged his indebtedness to those on whom he lavished his regard. During all the years in which he used even the night-watches for his investigations, the early hours of evening were spent, with free and joyous mind, in the midst of his family. He ever took more from himself than from others. Hospitality was the very genius of his house. With gentlest, heartiest courtesy his friends were welcomed to his fireside and his board. To those of scientific turn his rare and extensive scientific collections were opened with genuine delight. For those whose choice was in other directions, provision was made with equal care and gladness. Toward little children, and the young in general, his sympathies went forth with spontaneous freedom. He delighted to show to childish eyes, and to explain to childish comprehension, the beauties and marvels of Nature. Especially did he rejoice in giving encouragement to those who were struggling upward against great odds. The sight of such aspiration always awakened his enthusiastic interest. Not a few who to-day occupy positions of honor and usefulness owe their success to his appreciative, generous help. To envy his heart was wholly a stranger, and thus his friendships with men of science, both young and old, and with men great in other walks, were peculiarly tender and strong.

"In truth, his kindly interest included whatever affected the welfare of the race. He took pleasure in all honest effort. He exulted in all honorable achievement. He felt that he was personally indebted to whosoever made man better or more wise. In all social problems he took profound, unflagging interest. He sought to hold in view the progress of humanity in every land. In the alliance between religion and philanthropy and science he was a firm believer. He was confident that truth and right would triumph at last. To his perception the laws of Nature were the constancy of God's action, and Nature itself a transcript of the Eternal Mind."

EDITOR'S TABLE.

A GREAT SCHOLAR ON EVOLUTION.

AS many of our readers are doubtless aware, the "Fortnightly Review" has lately opened its pages to a discussion of the present relations between theology and the general thought of the age. The subject has been approached by several writers from different points of view; and we can not but believe that the conflict of opinions will result in some solid gain to the cause of truth. Meantime we are interested in the criticism which the Rev. Dr. Burgon, Dean of Chichester, one of the disputants, in replying to Canon Fremantle, whose article was reproduced in our last number, has bestowed on the doctrine of evolution. Dr. Burgon is, we believe, one of the highest authorities on the textual criticism of the Scriptures now to be found in the Church of England. He has devoted a long life, he himself tells us, *exclusively* to that study. One would suppose that a man conscious of having given *all* his attention to one line of thought and research would be diffident about his competency in another and widely different one. Not so with Dr. Burgon, however; he is quite satisfied that he is as well able to deal with the doctrine of evolution as with the age of a Greek manuscript; and in the April "Fortnightly" he tells us just what he thinks on that subject in very emphatic and unmistakable terms. It is, he affirms, "utterly unscientific," a "wild hypothesis," "the merest impertinence," "the veriest foolishness." Does the reverend gentleman advance any arguments in support of these powerfully expressed opinions? Yes; and one of them is, that "man is *never found at all in a fossil state.*" So convinced is the reverend doctor that this is a great truth, that he himself calls in the aid of italics to give it emphasis. Yet, had he opened the most elementary contemporary treatise on geology, he would have found that abundant fossil remains of man, and abundant traces also of his works, have been found in association with the bones of now extinct animals. The other arguments used by the doctor against the theory of evolution are drawn principally from the book of Genesis. He insists that man has not yet been quite six thousand years upon the earth, and quotes as an authority on that question Clinton, the author of "Fasti Hellenici." On the subject of miracles he has nothing better to tell us than that they are strictly analogous to human action in the realm of Nature: *ergo*, because man finds that he can do certain things by availing himself of natural laws, he must be ready to believe whatever may be told him of things done in apparent independence of all laws.

Dr. Burgon's article will do good. The extreme ignorance he manifests on scientific questions, and the unbounded confidence with which he nevertheless undertakes to discuss them, will open the eyes of many as to the pressing need for the scientific education of the clergy. A knowledge of manuscripts is all very well in its way; but a man who has to deal with the minds and hearts of other men, needs more than that. He needs to know the times he lives in, and the influences that are molding contemporary thought. Imagine, for a moment, a clergyman approaching an intelligent parishioner who is studying carefully the geological elements of the question as to the antiquity of man, and imagine that clergyman advising the parishioner to put aside his Lyell or his Geikie, and study Clinton's "Fasti" instead! Could a more absolutely absurd situation be conceived? Yet this is precisely what the learned Dean Burgon

(who does not even know that fossil remains of man were ever found) does with all of us—tells us, if we want to be satisfied as to the age of the human species, to dismiss geology altogether, and betake ourselves to the guidance of a long-deceased chronologist! Probably the dean will never know what a lamentable exhibition he has made of himself—never know that, while denying the existence of fossil man, he gave in his own person an unequaled specimen of a fossilized human intellect. It seems to us not unlikely that, years hence, the dean's "Fortnightly" article will be quoted as one of the latest examples of an extreme type of clerical ignorance on scientific subjects; just as we now indicate the period when the cave-bear and mammoth bade adieu to this terrestrial scene. It will be a happy thing, indeed, to have such ignorance safely packed away among the treasures of the past.

But now appears another phase in the controversy referred to. The Rev. W. Benham, who describes himself as a conservative, both in theology and in politics, undertakes to answer both Canon Fremantle, the Broadchurchman, and his assailant Dean Burgon. Naturally, Mr. Benham does not go as far as Canon Fremantle; but he makes one very important statement, and that is, that the majority of the clergy, so far as his acquaintance extends, seem to assume the truth of the doctrine of evolution. If a man of conservative tendencies is able to say as much as this of the clerical brethren with whom he most consorts, and who, we may presume, are in the main conservatives also, it is evident that thought is moving fast in the Church of England.

THE FIGHT AGAINST POVERTY.

As most of our readers are aware, an association has lately been formed in this city under the title of the "Anti-Poverty Society." It proposes to extirpate poverty by throwing the whole burden of taxation upon land. One may be allowed to doubt how far the proposed remedy, if found to be applicable, would go toward accomplishing the result desired; but, that poverty is an evil, and that the best efforts of modern society should be devoted to removing it, admits of no doubt. If the Anti-Poverty Society accomplishes no other good object, we trust it will at least, during the term of its existence, help to render the community more deeply sensible of its duty in this matter. When we speak of the community, however, we mean its individual members in their several private capacities, rather than the community as a politically organized body. We are not of those who hold that in legislation is to be found the cure for all social ills. On the contrary, we should be disposed to class what we may call the "legislation-habit" with what has been called the "alcohol-habit" in this important respect, that each implies resort to an artificial stimulus as a remedy for constitutional weaknesses—in one case in the social organism, in the other in the individual human body. Both involve distrust of, or disregard for, hygienic measures and the discipline of Nature; and both stand in the way of Nature's restorative action. If poverty is to be cured, we believe it can only be through the more general application of those principles and methods by which it is already warded off from the larger portion of society. The problem that has to be faced is the serious one of rendering every individual in the community fit to earn a maintenance for himself. Such fitness implies freedom from habits that are a burden upon life, from a physical or from any other point of view. Let the advocates of drastic measures of legislative reform say what they will, the fact remains that, given a certain measure of well-directed faculty, and success in the struggle of life becomes a sure thing. Instances abound in every country, but nowhere so much as in our own, in which men have risen,

not only from the humblest but from the most disadvantageous beginnings to positions of wealth and influence. It is all a question of fitness. In the social sphere, as elsewhere, the fit will survive and flourish; the pre-eminently fit will flourish pre-eminently. It may be that pre-eminent fitness for present social conditions may not imply ideal excellence of character; no doubt it does not; still the fact remains that success is a question of adaptation, and that want of success or poverty means non-adaptation.

All this may seem very trite, but it would not be safe to argue that because a thing is trite all the good it is capable of yielding has been extracted from it. In the general craze for novelty, old truths are abandoned before they have been half worked out. The theories of the Anti-Poverty Society are very taking with the multitude; but we venture to predict that, after they have had their day, men will find that there is still much to do on the old lines to which we are now calling attention. The way to kill poverty, we hold, is to kill it individually—that is to say, to bring such influences to bear on the unfit as shall render them fit; to make war against idleness, inefficiency, stupidity, extravagance, weak self-indulgence, and all else that makes for poverty either by diminishing the productiveness of labor or by promoting undue consumption. It is sometimes held that the laboring classes do not get their fair share of the proceeds of their industry; but the fact is not insisted on as it might be that the share they get will at any given time be directly proportional to their own inherent merits as workers and as men. The question is how near can they come to negotiating on a footing of perfect equality with the employers of labor, and that depends upon the bearing and attitude which they are enabled to assume. A body of thoroughly intelligent and self-respecting men, with established habits of self-control and general capacity for self-guidance, would enter upon the negotiation with far better chances of concluding it to their satisfaction than would a body of men less intelligent and less under moral control, even allowing the latter the benefit of all the most improved appliances for industrial war, including street-rioting and the persecution of "scabs." It is mainly a moral and intellectual reform that is wanted; and we are far from saying that it is wanted only in the ranks of those who earn their bread by the labor of their hands. No serious person can consider the extravagance which now marks the expenditure of the middle and upper classes (if we may without offense use such terms as these to indicate comparative degrees of wealth), without feeling that a bad example of profusion and ostentation is shown to the wage-earners—that a wrong ideal of life is set before them. It is true now, as ever, that a man's life "consisteth not in the abundance of the things that he possesseth"; but it hardly seems as if any one to-day believed it. The majority at least only seem to live in proportion as they surround themselves with visible and tangible evidences of their material prosperity. One consequence—very important in relation to our present subject—is that a standard of living is set up which not all who become accustomed to it can permanently maintain; and thus extravagance leads to poverty. How many are miserably poor to-day whose parents brought them up in comfort, if not in affluence! We say "miserably poor," because poverty is never so miserable as when complicated with vain regrets and a general sense of disinheritance and decay. If we would fight against poverty, therefore, we must fight against it everywhere, and try to make all classes of society understand that life is a struggle for which a definite equipment is required, and that no part of that equipment is more essential than moderation of desire. Much, also, as the Malthu-

sian doctrine is flouted in some quarters, and particularly in the region of the Anti-Poverty Society, the sober thought of the more instructed portion of mankind will incline them to believe that there is something to be said on behalf of prudence in incurring what is simply the most solemn and important responsibility than can be assumed by any human being. That poverty has been greatly promoted by carelessness and indifference in this regard—a blind trusting to chance or Providence—few, we think, would deny.

But perhaps the most important single aspect of the whole question is the sanitary or hygienic. As long as there are debilitated frames, enfeebled wills, and morbidly developed passions, there will be poverty. On the other hand, of course, poverty tends to increase and perpetuate these evils. This aspect of the subject has lately been treated with much force in the body of the "Monthly," and we shall not dwell upon it today. The main truth we wish to emphasize is that poverty results from unfitness for social conditions, and that the true mode of conducting an anti-poverty campaign would be to attack at every point those errors and vices that tend to depress human beings below the level at which they can fulfill the conditions needful for their maintenance in health and well-being.

LITERARY NOTICES.

PUBLIC DEBTS: AN ESSAY IN THE SCIENCE OF FINANCE. By HENRY C. ADAMS, Ph. D. New York: D. Appleton & Co. Pp. 407. Price, $2.50.

THE purpose of this treatise is to portray the principles which underlie the use of public credit. While it is neither primarily statistical nor historical, it relies upon statistics, and makes frequent appeals to history; and in these points, the experiences of our national Government, so comprehensive and recent, and of our State and local governments, so various and often so impressive, afford a rich fund whence illustration and the "clinchers" of argument are drawn. The peculiarity of our Federal Constitution necessitates a distinction in the treatment of the subject as between national deficit financiering and local deficit financiering (State and municipal) which is not recognized by European writers. Of the three parts into which the treatise is divided, the first is devoted to the general subject of "Public Borrowing as a Financial Policy." The immense development of public indebtedness which the world is now witnessing, which has reached an aggregate for the civilized states of $27,000,000,000, has taken place since 1848, when the total stood at $8,650,000,000. Searching for the causes of this accumulation, they are found to lie mainly in the greater strength and effectiveness of the feeling of nationality, for the maintenance of which large expenditures are necessary, and in the spirit of socialism, or the disposition of states to legislate and undertake in the interest of the social well-being of their peoples. Concerning the political and social tendencies and industrial effects of public borrowing, it is held that it tends to obviate the free workings of constitutional governments, to endanger the autonomy of inferior states, and to introduce complications between the larger powers. Socially, public debts render permanent such class relations as spring from disparity of possessions, and introduce conflicting interests between citizens. The industrial effects are complex, and depend upon the nature of the loan, the conditions under which it is contracted, and upon the fund of capital from which it is filled. They are harmful in proportion as the placement of the loan disturbs the market value of commodities. Public credit may be advantageously employed—as opposed to material increase of taxes—to cover running deficits, to assist in meeting unforeseen emergencies, and to provide revenue for carrying on public improvements. In the second part—"National Deficit Financiering"—the first topic is the "financial management of a war," the principle of which, as summarized, is "that reliance can not be placed wholly upon loans nor wholly upon taxes, but fiscal administration should be so adjusted as gradually to change the burden of expenditure from credit to clear income." As between the differ-

ent forms the debt may take, floating debts should be but sparingly used; voluntary loans appeal to the only reliable motive on which to rest a credit policy; bonds are preferable to annuities; and while Government may use its discretion in fixing times of payment, loans should be placed at par rather than at discount. At the close of a war, floating debts should receive immediate attention, and a policy of contraction should be set on foot to meet the case of irredeemable paper notes. In peace management, the financier should have regard to the need of investors in giving shape to the public debt; should be able to work wisely when he comes in contact with the money market, and harmoniously with all laws affecting or affected by his securities; and "should have clear views respecting the policy of conversion." The policy of debt-payment—as opposed to holding on till the indebtedness is overtaken by the growth of the country in wealth—is defended, but it should not be pushed so rapidly as to force the rate of business profit below the rate necessary to sustain industrial hopefulness. The best method of payment is that of making permanent appropriation to the service of the debt, leaving the administration large discretion in its application.

In the third part—"Local Deficit Financiering"—a review of the past experiences and present condition of the States and municipalities in financial management leads up to inquiries into the causes of municipal corruption, and the expediency of limiting the power of cities and States to borrow money. Municipal corruption is regarded as merely a symptom of deep-seated disorder in the body politic, and not a distinct and independent evil. The final explanation of the phenomena is to be found in the fact that the present organization of society does not properly correlate public and private activity. Private business and the service of corporations offer more attractive careers than municipal office, and secure the service of the best men. The remedy for corruption is, then, to enlarge the scope and legitimate emolument of municipal life, so that the best men may also be attracted to it; and this should be supplemented by the enforcement of personal responsibility. While the evils against which the restrictions of the freedom of States and municipalities in financial and industrial matters have been directed, are acknowledged to have been real evils, the method that has been adopted of curing them is believed to have brought great danger to society. In this sphere regard must be had (or our institutions are imperiled) to the two fundamental principles of republicanism: that all concentration of power should be held to strict accountability; and that the exercise of all responsible power should lie as closely as possible to the people upon whom it is to fall. The present standing of private corporations before the law contradicts the first rule; for "these corporations are practically irresponsible to the people by whose favor they exist, and whom they pretend to serve. Popular liberty could be menaced by no greater danger." The growing importance of the Federal Government threatens to disregard the second rule, that responsible power should lie as closely as possible to those upon whom it is exercised. Yet "the financial disabilities under which the States rest have placed them *hors de combat;* and, without some radical modification of existing relations between the various centers of government, the pressure of coming events will inevitably lead to an extension of administrative functions under the direct control of Congress." Moreover, as the country becomes more populous, and its various relations more complex, the functions of government must necessarily extend to continually new objects. The States are the proper center for their exercise, but they are considered as being in no position for performing the duty, having been deprived of the facilities for undertaking it by a series of mistakes. Hence, we have reason to regard with solicitude the next step in the development of the industrial constitution of the United States.

The author has evidently endeavored to view judicially the various questions he has raised, and has given a book full of thoughts which it was well to have presented.

OIL AND NATURAL GAS IN ILLINOIS. By THEODORE B. COMSTOCK. Pp. 15.

THE author in this paper, which was read before the Illinois Engineers' and Surveyors' Association, discusses the probability

of finding oil and gas in paying quantities within the limits of the State and the districts in which searching for them will be most hopeful. He believes that the accumulation of oil is connected with certain uplifts of the strata indicating faults, and points out certain lines of such dislocations as regions in which the discovery of oil or gas is more or less probable.

PROCEEDINGS AND TRANSACTIONS OF THE SCIENTIFIC ASSOCIATION. Meriden, Conn. 1885–'86. CHARLES H. S. DAVIS, M. D., Secretary. Pp. 64.

THE Association, at the beginning of its sixth year, had one hundred and thirty members. Nine papers were read before it in 1885 and eight in 1886; an excursion was made to the Portland quarries; and among the lecturers in 1886–'87 were Alfred Russel Wallace and Professor Alexander Winchell. The volume of the Transactions contains an account of the *Catopterus gracilis*, a fossil fish found at Little Falls, by Dr. Davis; a study of "the Hanging Hills," as the trap ridge at Meriden is called, by J. H. Chapin, D. D.; "A Notice of Certain Fossil Plants in the Quarries at Durham"; "A List of the Birds of Meriden," by Franklin Platt; "Additional Plants found growing at Meriden," by Mrs. C. B. Kendrick; and a poem on "West Peak, and what it saith," by the Rev. J. T. Pettes.

A CENTURY OF ELECTRICITY. By T. C. MENDENHALL. Boston: Houghton, Mifflin & Co. Pp. 229. Price, $1.25.

IN this book Professor Mendenhall has presented within a small compass an account free from technicalities, of the growth of the world's knowledge of electricity and its applications. The frictional electric machine, the Leyden-jar, and Franklin's lightning-rod, represented about all that was known concerning electricity in 1786, when Galvani turned a gastronomic delicacy to account as an instrument for scientific research. Volta's invention of the battery, or "pile," followed within the next decade, and made possible the rapid progress in electrical discovery which followed. Nicholson, Carlisle, Davy, Wollaston, and Daniell, are some of the prominent names of the next few years.

In 1820, Oersted, the son of a Danish apothecary, who had become Professor of Physics in the University of Copenhagen, discovered the action of a current of electricity on a suspended magnetic needle. Within one week after hearing of Oersted's discovery, Ampère had worked out the fundamental principles on which rests the whole science of electro-dynamics. The credit of discovering that electro-magnets of great power may be made by winding the core with many turns of insulated wire, belongs to an American—Joseph Henry—and the telegraph was first made a permanent commercial success by another American—Professor Morse—although various forms of the needle-telegraph had appeared in Russia, Germany, and England.

Multiplex telegraphy and the use of submarine cables are extensions which followed in due time. With the discoveries of Galvani and Oersted must be ranked another, by Faraday, on which rest "nearly all the more recent and more striking applications of the electric current." This was the discovery of electro-magnetic induction. The dynamo-electric machine, and with it the commercial use of the electric light, were thus made possible. The discovery that the dynamo is reversible, i. e., that it will run as a motor if a current is supplied, opened the way for the next great step, hardly yet consummated, the electric transmission of force. Meanwhile electricity had been set at work in the domain of acoustics also, and that wonderful invention, the telephone, was produced. The development of electrical storage, and the direct production of electricity from heat, belong rather to the coming than to the completed "Century of Electricity."

THE STORY OF ANCIENT EGYPT. By GEORGE RAWLINSON, with the Collaboration of Arthur Gilman. New York: G. P. Putnam's Sons. Pp. 408. Price, $1.50.

THE history of this most ancient of the empires of the earth, with its old and advanced civilization, is here told in a connected, current manner, more satisfactorily than in any other book for popular reading with which we are acquainted. The history of Egypt is in fact hard to present acceptably to the general public. The ancient writers upon whom we once depended were inadequate and contradictory. The modern sources—the recovered monuments and in-

scriptions—are suggestive as to what the facts may have been, rather than satisfying as to what they were; and the gaps between them are so numerous and so wide as to make a complete restoration of the history still impracticable. Hence wide differences of opinion as to many of the essential features still prevail among those who are equally entitled to be regarded as authorities. Yet great advances have been made in the study, and a large number of the more important facts have been made certain. They are almost enough to give us the clew to the course of the history from the beginning. These facts the authors have sifted from the conjectures and speculations and discussions of controverted points with which the literature respecting ancient Egypt is encumbered, and have presented them in their order, and with reference to their bearing; and they have thus given, in a readable shape, a notion of what is actually known on the subject.

THE STORY OF THE NORMANS. Told chiefly in Relation to the Conquest of England. By SARAH ORNE JEWETT. New York: G. P. Putnam's Sons. Pp. 373. Price, $1.50.

THIS is one of the volumes of the happily conceived "Story of the Nations" series, and the one, perhaps, of those which have been published, that possesses the most immediate interest to American readers, as telling of a people through whom, in more than one sense, we partly derive our ancestry and our institutions. The story is presented in the attractive form of a running narrative, in which, while the history is faithfully adhered to and presented in its connection, scope is given for the full play of the romantic features and lively incidents which appear to be inseparable from our conceptions of Norman history, feudalism, and the life of the middle ages.

THE ANNUAL INDEX TO PERIODICALS FOR 1886. Bangor, Me.: Q. P. Index, Publisher. Pp. 27.

THIS is the sixth annual issue of this Index and the second in the series of "Cumulative Indexes." It furnishes a complete index for the year to more than twenty-seven periodicals. By a system of notation which, odd as it looks at first, is easily learned and proves to be simple when learned, articles are referred to their authors and authors to their articles, and both to the precise issues of the several magazines in which they appear. Another set of symbols indicates the precise character of the several articles, The whole is put into so compact a shape that the present thin volume contains sixteen hundred and eighty-eight separate entries.

FIRST BOOK OF CHEMISTRY: A COURSE OF SIMPLE EXPERIMENTS FOR BEGINNERS AT HOME AND IN PRIMARY SCHOOLS. By MARY SHAW BREWSTER. New York: D. Appleton & Co. Pp. 144. Price, 77 cents.

To make the educational influence of the study of chemistry available for young pupils is the object of this little hand-book. In the words of the preface, "It aims to stimulate in the beginner, by the natural method of observation and experiment, a desire to know about every-day phenomena—to lead him to question for himself, and then to answer his own inquiry, not by appealing to book or teacher, but by reference to the facts presented." Generally the pupil is told only how to proceed, and is left to discover the results of experiments by his own observation. Only those experiments are employed whose bearings can be readily comprehended, and which can be performed with utensils and materials found in the homes and stores of any village. But little of chemical theory or nomenclature has been introduced. The pupil is first led to observe the difference between a mixture and a chemical compound, and is further made acquainted with chemical affinity, solution, crystallization, precipitation, filtration, and other fundamental ideas and processes. Then, after a presentation of the properties of acids, bases and salts, the common elements are taken up separately. The book is illustrated, and contains lists of apparatus and materials needed for experiments.

REPORT OF THE LADIES' HEALTH PROTECTIVE ASSOCIATION OF NEW YORK. 1885–'86. Mrs. M. J. Herbert, Secretary. Pp. 15.

THE Association was organized in November, 1884, for the purpose of dealing with some of the "east-side nuisances" of

New York city. It had eleven members at the beginning; at the end of the first year it had more than six hundred members. The ladies seem to have gone into their enterprise with much energy, before which several established nuisances, that had long baffled the political powers, had to give way. Their influence was felt in New Jersey, where they were called on to help remove some offensive conditions, and in the State Legislature, where they labored to prevent damaging legislation.

CALIFORNIA STATE MINING BUREAU. Sixth Annual Report of the State Mineralogist. Part I. By HENRY G. HANKS. Pp. 145. Part II. By WILLIAM IRELAN, Jr. Sacramento. Pp. 222.

THE first part, besides a general statement of the condition of the Bureau and its collections and a reference to the comparative merits of mining and manufacturing as adapted to California, gives a paper on "Building-Stones and Building-Materials in California," with a list of the stones and their localities; a table of altitudes of twelve hundred and ninety-seven points; accounts of the "Mineral Springs of California"; descriptions of "The Calistoga Silver-Mines"; and the geology and mineralogy of San Diego County. The second part contains the special report of the trustees of the Bureau; accounts of a considerable number of mines and of the processes and machinery employed at them; summaries of the mineral products of the United States in 1885; the mining laws of the United States and the departmental interpretations of them; various tables and rules of use in mining; and tables of legal distances and routes of travel in California.

OTTAWA FIELD NATURALISTS' CLUB. Transactions No. 7, 1885. W. H. Harrington, President. Ottawa, Canada. Pp. 90.

THE Club appears to have enlisted a full representation of the persons within its sphere of action who are interested in its work. Three Club excursions were made, while the sub-excursions were more numerous and more successful than in any previous season. Ten afternoon lectures or classes were held during the winter, on entomology, mineralogy, ornithology, and botany. The fact that six of the meetings were held in educational institutions is regarded as indicating that the Club is being more and more recognized as able and willing to impart instruction in the natural sciences. With the "Transactions" are embodied the special reports of the geological, conchological, entomological, ornithological, and botanical branches of the Club; papers on the "Black Bear," by Mr. W. P. Lett, and "Ottawa Dragon-Flies," by Mr. T. J. MacLaughlin; a "List of Mosses collected near Ottawa," by Professor J. Macoun; and "A New Departure in the Study of Minerals," by the Rev. C. F. Marsan.

MATHEMATICAL TEACHING AND ITS MODERN METHODS. By TRUMAN HENRY SAFFORD. Boston: D. C. Heath & Co. Pp. 47. Price, 25 cents.

THIS paper is one of a series of "Monographs on Education," which the publishers have undertaken for the purpose of preserving a class of essays on the theory or practice of teaching which, not being suited for popular magazine articles or voluminous enough for books, are, while they are of great value, in danger of being lost. The thoughts expressed in the paper are such as have been suggested by the author's long practical experience in giving instruction in mathematical subjects, and the conclusions are believed to be in agreement with the views of progressive educators, but not with ordinary traditions. "It is an old complaint against mathematics as a mental discipline," says the author, "that it is too abstract and unpractical. When we look at the ordinary courses in our colleges and schools, we shall find that there is much truth in this; but the complaints are entirely groundless when mathematics takes its proper place in our courses, and is taught in the proper manner." It is the object of the essay to search for the "proper manner."

MCCARTY'S ANNUAL STATISTICIAN, 1887. Edited by L. P. MCCARTY. San Francisco: L. P. McCarty.

THE usefulness of well-edited and comprehensive compilations of statistics goes without saying as a valuable *vade mecum* for the editor, politician, scholar, even for professional men and merchants. Of these hand-books we have many more or less

complete, but certainly, in respect of volume and mass of information, the book before us is well ahead of its rivals. It includes nearly everything of interest, both as to Europe and America, relating to commerce, industry, agriculture, manufactures, finance, education, politics, and history. Elaborate tables, embodying the latest results, and in many cases comparative tables showing the aggregates of different years from a decade to a half-century, enable one to grasp the growth of each interest at a moment's glance. It may be said that in all such books it is not practicable to secure an orderly and systematic arrangement. Mr. McCarty has met the difficulty as well as possible by giving a very thorough index to the contents. The material seems to have been gathered with great care and industry, and presumably the citations of figures are trustworthy, except so far as errors have crept in through bad proof-reading. Mr. McCarty's plan appears to have been to make this a most exhaustive book of its class, and in the extent of the field he covers he has not fallen short of his aim. It is not easy to overrate the amount of labor essential in the compilation of such a work, and its value to the public is in direct ratio. About one half of the book is devoted to the United States. In addition to statistical matter proper there are about one hundred pages devoted to scientific, mechanical, and commercial facts and formulas.

THOUGHTS ON SCIENCE, THEOLOGY AND ETHICS. By JOHN WILSON, M. A. London: Trübner & Co., pp. 197.

"THE object of this little book," says the preface, "is to give a correct sketch of the main lines of modern thought in small compass and in language simple enough to be easily understood." This object, it seems to us, has been attained with more than usual success. It is an excellent work to put into the hands of the young who are beginning to think and seeking to learn how to think. The distinction drawn between science and theology with respect to the meaning of the word "God" illustrates the theoretical doctrines of the author. "God," he says, is "the Omnipotent Power which exists behind the facts of the universe. Of this power science asserts the existence to be a necessary supposition, but the nature to be to us unknowable and inconceivable. Theology, on the other hand, asserts its nature to be known, and conceives it to be manlike." This is exceedingly well put. Proceeding from this declaration, the points of opposition between science and theology are made very clear. The necessity of a scientific foundation for ethics is set forth in the second part of the work. The first part treats, in successive chapters of "What is Science?" "What is the Use of Science?" and "The Methods of Science." Part second deals with "The Object and Scope of Ethics," "The Origin and Nature of the Moral Code," and "The Sanction of the Moral Code." We hope this meritorious book will be widely circulated.

VAN NOSTRAND'S SCIENCE SERIES.

No. 90.—ANALYSIS OF ROTARY MOTION, AS APPLIED TO THE GYROSCOPE. By Major J. G. BARNARD, A.M. New York: D. Van Nostrand. Pp. 66. Price, 50 cents.

MAJOR BARNARD'S analysis, which is here republished, is based on the works of Poisson. The author shows first how the particular equations of the gyroscopic motion may be deduced from the general equations of rotary motion, and then points out that the analytical results arrived at contain within themselves the sole clew to the visible phenomenon, and dispel all that is mysterious and paradoxical.

No. 91.—LEVELING; BAROMETRIC, TRIGONOMETRIC, AND SPIRIT. By IRA O. BAKER, C. E. New York: D. Van Nostrand. Pp. 145. Price, 50 cents.

THE matter in this treatise forms a part of the lectures on geodesy given by the author to his classes at the University of Illinois, and is published for the use of his own and other students. The author does not claim that there is anything new or original in the volume; but he has combined in a single book information that heretofore could only be found scattered through many. His object has been to give all that was necessary for a thorough comprehension of the principles involved, and an intelligent understanding of the method of applying them. The attempt has been made to point out all the sources of error, and to give accurate data showing the degree of

accuracy attainable by each method of leveling.

No. 92.—Petroleum: Its Production and Use. By Boverton Redwood, F. I. C., F. C. S. New York: D. Van Nostrand. Pp. 210. Price, 50 cents.

The material of this volume is abridged from a series of Cantor lectures given before the Society of Arts, London, and originally published in the journal of the society. The parts omitted are such as were deemed of no interest to American readers. Almost every topic relating to petroleum has been considered, beginning with the kinds of rocks in which petroleum is found, in the United States and in the Baku district, and taking up in succession the chemistry of petroleum, the construction of wells, methods of transporting crude petroleum, the manufacture of commercial products and their transportation, methods of testing oils and paraffine in considerable detail, followed by a sketch of the progress of invention in oil-lamps.

Massage as a Mode of Treatment. By William Murrell, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 100. Price, $1.25.

The attention which has been given recently to massage, in medical books and journals, has excited a demand for a more general introduction of that method of treatment, and for operators. But much ignorance still prevails upon the subject, both among those who require massage and among those who offer themselves as operators. It is too important a matter to be trifled with, and the remedy is too beneficial a one to be neglected when it is practicable to secure its proper application. Hence this little book, telling exactly what massage is, and how it should be applied, and how the operator should be qualified, fills a felt want. It gives the history of massage; an account of the method of performing it, describing particularly the Von Mosengeilian system as practiced in Holland and Germany; chapters on "The Masseur and the Masseuse" (male and female operators) and "The Physiological Action of Massage"; and indications as to the class of cases in which it is most likely to do good. On the last point the author says: "The ignorant rabble of course thinks that it will cure everything, but as a matter of fact its sphere of action is very limited. If carried out under the direction of a scientific physician, who has had experience in this mode of treatment, it yields excellent results; but if allowed to drift into the hands of an ignorant empiric, it soon degenerates into the most arrant quackery."

Profit-Sharing. By N. O. Nelson, St. Louis, Mo. Pp. 40.

This pamphlet is a collection of articles which were written by the author on different occasions, but always by request, holding up the plan of giving to workmen an equitable share in the profits of the business as the true solution of the so-called "labor question." Force is given to the arguments by the fact that the system which the author advocates has been introduced into the manufacturing establishment with which he is connected, and is in successful operation there. Two of the papers are devoted to accounts of the introduction and workings of the plan.

Proceedings of the Department of Superintendence of the National Educational Association, February, 1886. Washington: Government Printing-Office. Pp. 90.

This is published as one of the "Circulars of Information" of the Bureau of Education. More than sixty superintendents and persons actively interested in education attended the meeting. Among the topics considered in papers read and in discussions were, "The Duties of County Superintendents," "Reading Circles for Teachers," "Co-education of the Races," "Educational Statistics," "The Educational and Religious Interests of the Colored People of the South," "Forestry in Education," "Language-Work," "Growth and Benefits of Reading Circles," and "City Superintendence."

The Labor-Value Fallacy. By M. L. Scudder, Jr. Chicago: The Patriots' League. Pp. 112. Price, 10 cents.

This pamphlet is the first of a series to be published by the "Patriots' League"—an association of conservative citizens whose purpose is to combat socialist heresies and

their kindred, and to disseminate sound views—and to be sold at cost. Its principal aim is to controvert the dogma of the trades-unions that it is the labor element which determines the exchangeable value of commodities.

JOURNAL OF THE ELISHA MITCHELL SCIENTIFIC SOCIETY. 1885–'86. E. P. Venable, Chapel Hill, N. C., Secretary. Pp. 146, with Map. Price, 50 cents.

THE report covers the third year of the work of the society, which is also mentioned as the most prosperous year it has enjoyed. Regular monthly meetings of members and invited guests have been held for hearing papers and discussing scientific questions of interest. The feature of public lectures has developed into the University (of North Carolina) Lecture course, continuing through the session. Sixty-one papers were read and presented at the meetings of the society, about one third in number of which are given in the present number of the "Journal." Of these papers two are of very general interest, viz.: "The Sketch of the Life and Scientific Work (in botany) of Lewis David Schweinitz," which is accompanied by a portrait; and Messrs. Wood and McCarthy's "Wilmington (N. C.) Flora," including a list of the plants and date of flowering, and accompanied by a map of Hanover County. A beetle that infests tobacco and cigarettes is described by Mr. G. F. Atkinson.

ECONOMIC EQUITIES. A COMPEND OF THE NATURAL LAWS OF INDUSTRIAL PRODUCTION AND EXCHANGE. By J. K. INGALLS. New York: The Truth-Seeker Company. Pp. 63. Price, 25 cents.

THE author is of opinion that a proper solution of the questions he has in view can not be reached "while deferring to the traditions and institutions of barbarous ages, or to the prejudices and sordid maxims of the very rich and powerful"; or by looking at them from the point of view of employers or of wage-workers as a class. He has sought, impartially, to ascertain the true nature of the relation of earth and man to social industry and reciprocal exchange. The result of his search is an obvious inclination toward the theories of the kind upheld by Henry George.

ELEMENTS OF ENGLISH. By GEORGE HODGDON RICKER. Chicago: The Interstate Publishing Company. Pp. 106. Price, 30 cents.

THIS book is intended to be an introduction to English grammar for the use of schools. It aims to make the branch less difficult, more attractive, and more useful to young pupils. It is designed for the lower grades of schools, and to be preparatory to larger works. It consists of a series of lessons, treating of the parts of speech and their uses, and of the simple sentence in its various forms, which are illustrated by practical exercises composed of words in common use. It also contains lessons on spelling, capital letters, punctuation, directions for letter-writing, the principles of analysis and synthesis; and brief methods of parsing.

PUBLICATIONS RECEIVED.

Latham, John, Managing Editor. The "Esoteric." Vol. I, No. 1. Monthly. Boston: Esoteric Publishing Company. Pp. 32. 15 cents. $1.50 a year.

Walker, Francis A. Arithmetic in Primary and Grammar Schools. Pp. 29.—A Plea for Industrial Education in the Public Schools. Pp. 34. Boston: Damrell & Upham.

Hamilton, Dr. A. "The Fonetic Herald." 1886, and January and February, 1887. Monthly. Pp. 4 each number. Port Hope, Ont.

Shufeldt, R. W. Contributions to the Anatomy of Geococcyx Californianus. Pp. 16. With Four Plates. Additional Notes upon the Anatomy of the Trochili, Caprimulgi, and Cypselidæ. Pp. 3.

Blakiston, Son & Co., Philadelphia. New Series of Manuals and Text-Books for Students. Announcement.

Zoölogical Society of Philadelphia. Fifteenth Annual Report. Arthur Erwin Brown, General Superintendent. Pp. 20.

Alabama Weather Service. Report for April, 1887. P. H. Mell, Jr., Director. Auburn, Ala. Pp. 6.

Riley, C. V. Shade-Trees and their Insect Defoliators. Pp. 69.—Reports of Experiments with Various Insecticide Substances. Pp. 34.—Miscellaneous Notes on the Work of the Division of Entomology for the Season of 1885. Pp. 45. With Plates. Washington: Government Printing-Office.

Lighthall, W. Dourr. Sketch of a New Utilitarianism. Montreal: "Witness" Printing-House. Pp. 40.

Mathews, Robert. Competition and Monopoly. Rochester, N. Y. Pp. 14.

D. T. Smith. The Gathering of the Waters; or, The Evolution of Seas and Rivers. Louisville, Ky. Pp. 8.

Newton, James King, Oberlin, Ohio. Obligations of the United States to initiate a Revision of Treaties between the Western Powers and Japan. Pp. 25.

Lloyd, James Hendrie, Philadelphia. The Claim of Moral Insanity in its Medico-Legal Aspects. Pp. 16.

Hayes, Henry. The Story of Margaret Kent. Boston: Ticknor & Co. Pp. 444. 50 cents. (Ticknor's Paper Series.) Weekly, No. 1.

Miller, Annie Jenness, Editor. "Dress." Monthly. Devoted to the Practical and Beautiful in Women's and Children's Clothing, etc. New York: The Gallison and Holborn Company. Vol. I, No. 1. Pp. 34. 15 cents. $1.50 a year.

Mays, Thomas J., M. D., Philadelphia. Does Pulmonary Consumption tend to exterminate the American Indian? Pp. 8.—An Experimental Inquiry into the Chest Movements of the Indian Female. Pp. 11. Detroit, Mich.: George S. Davis.

Morel, Dr. V. New Treatment of the Affections of the Respiratory Organs and of Blood-Poison, by Rectal Injections of Gases. Pp. 21. Also Reprints of Articles on the same, and List of Apparatus. Pp. 18. Philadelphia: James W. Queen & Co.

Jackson, C. Loring, and others. Contributions from the Chemical Laboratory of Harvard College. (Five Papers.)

Chaillé, Stanford E., Tulane University, La. Abuse of Alcoholics by the Healthy. Pp. 36.—Infants; their Chronological Progress. Pp. 20.

Public Health in Minnesota. Red Wing, Minn. State Board of Health. Pp. 8.

Walker, James, Cincinnati. Remarks and Criticisms on Articles about Brewing. Pp. 26.

Bolton, Henry Carrington, Hartford, Conn. Alchemy and Numismatics. Pp. 12.

"Once a Month." A Journal for Young People, Newark, N. J.: Richard W. Bloemeke. Pp. 16. 5 cents. 60 cents a year.

Kitao, Diro. Beiträge zur Theorie der Bewegung der Erdatmospäre und der Wirbelstürme. (Contributions to the Theory of the Movement of the Earth's Atmosphere and of Hurricanes.) Tokio, Japan. Imperial University of Japan. Pp. 96. With Plates.

United States National Museum. "Proceedings," four sheets. Washington: Smithsonian Institution.

Halstead, Byron D. Bulletin of the Iowa Agricultural College, from the Botanical Department. Pp. 66.

Plumb, Charles S. "Agricultural Science." Monthly. May, 1887. Geneva, N. Y. Pp. 24. $2 a year.

Bocock, Kemper, Philadelphia. A Plea for Area Taxation. Pp. 32.

Stone, George H., Colorado Springs, Col. Terminal Moraines in Maine. Pp. 8.

Averil, William D., Chestnut Hill, Philadelphia. "The Conchologists' Exchange." Monthly. Pp. 12. 8 cents. 85 cents a year.

Huston, H. A., Director, Lafayette, Ind. The Indiana Signal Service. Pp. 9.

Isms, Material, Occult, and Spiritual, and their Influence in determining the Religion of the Future. Cincinnati: Robert Clarke & Co. Pp. 85. 40 cents.

Beall, F. M. M. "Monthly Weather Review, of United States." March, 1887. Washington City: Signal-Office. Pp. 28.

Behmer, George H. List of Astronomical Observatories. Washington: Government Printing-Office. Pp. 14.

Smithsonian Institution. Miscellaneous Papers relating to Anthropology. Pp. 44.

Bournot, John George. Local Government in Canada. An Historical Study. Baltimore: N. Murray. Pp. 72. 50 cents.

Williston, Samuel W. Synopsis of the North American Syrphidæ. Washington: Government Printing-Office. Pp. 335.

Thomann, G. Colonial Liquor Laws. New York: United States Brewers' Association. Pp. 202.

Erichsen, Hugo, M. D. The Cremation of the Dead. Detroit: D. O. Haynes & Co. Pp. 264. $2.

Bastin, Edson S. Elements of Botany. Chicago: G. P. Engelhard & Co. Pp. 282. $2.50.

James, Frank L. Elementary Microscopic Technology. Part I. St. Louis Medical and Surgical Journal Company. Pp. 107. 75 cents.

American Society of Microscopists. Proceedings, Ninth Annual Meeting, 1886. Buffalo, N. Y., D. S. Kellicott, Secretary. Pp. 243.

"Doctor Frank." Health in our Homes. Pp. 112. 75 cents.—Health of our Children. Pp. 128. 75 cents. A Friend in Need; a Household Guide in Health and in Disease. Pp. 460. $3. Boston: Thayer Publishing Company.

Tolstoi, Count Léon. Katia. New York: William S. Gottsberger. Pp. 198. 50 cents.

Bell, George W. The New Crisis. Des Moines, Iowa: Moses Hull & Co. Pp. 351.

Oldberg, Oscar. A Manual of Weights and Measures, with Rules and Tables. Chicago: Charles J. Johnson. Pp. 246. $1.50.

Jameson, J. Franklin. Willem Usselinx, Founder of the Dutch and Swedish West India Companies. New York: G. P. Putnam's Sons. Pp. 234. $1.

Laing, Samuel. A Modern Zoroastrian. London: F. V. White & Co. Pp. 265.

Sutton, John Bland. Ligaments, their Nature and Morphology. Philadelphia: P. Blakiston, Son & Co. Pp. 107. $1.25.

Rosmini, Antonio Serbati. The Ruling Principle of Method applied to Education. Boston: D. C. Heath & Co. Pp. 368. $1.50.

Dudley, Marion V. Poetry and Philosophy of Goethe. Chicago: S. C. Griggs & Co. Pp. 300.

Thompson, Maurice, Indianapolis, Indiana: Geology and Natural History. Fifteenth Annual Report. Pp. 359.

United States Commissioner of Education. Report for 1884–'85. Washington: Government Printing-Office. Pp. 848.

Browne, Lennox, and Behnke, Emil. Voice, Song, and Speech. New York: G. P. Putnam's Sons. Pp. 248.

Thompson, Daniel Greenleaf. The Problem of Evil. London: Longmans, Green & Co. Pp. 281.

Academy of Natural Sciences of Philadelphia. Proceedings, 1887. Sheets 4 and 5.

Marsh, O. C. Dinocerata: A Monograph on an Extinct Order of Gigantic Mammals. Washington: Government Printing-Office. Pp. 243, with 56 Plates.

POPULAR MISCELLANY.

The Glacial Lake and Island of Cincinnati.—The city of Cincinnati occupies, as Professor Joseph F. James remarks, one of the most interesting geological positions on the North American Continent. The strata of its hills are almost wholly composed of Lower Silurian fossils, in nearly perfect preservation, packed as closely as they can be stowed together. Besides this, it furnishes most interesting marks of the conditions which prevailed in the region in glacial and pre-glacial times. After the close of the glacial period, in the presence of the *débris* left by the ice-sheet, blocking up in places the beds of the former streams, new channels had to be sought by the water. Many streams were compelled to form entirely new channels, but others had to carve

new courses only in places here and there. The Ohio River seems to have been in the latter category, for in many places its valley is too wide and too deep to have been excavated by the volume of water now flowing at ordinary stages. In fact, there seems little doubt that the Ohio flows in a channel which was cut long previous to the glacial period. This old channel has been largely filled up, and the river now flows from thirty-five to forty feet above its ancient bed. This seems to be proved by the discovery, at that depth below the present surface of the ground, of an extensive bed of carbonaceous material consisting of stumps of trees, leaves, seeds, and other vegetable remains. Several facts seem to point to the conclusion that on and near the site of the city was once spread out a sheet of water that assumed almost the aspect of a lake. The outlet of this sheet was not like the present course of the river, past the mouth of Mill Creek, but up what is now Mill Creek Valley on one side, and up the Little Miami Valley and an ancient channel between Red Bank and Plainville on the other side, of what then formed an island now occupied by a part of the hill suburbs of Cincinnati. These ancient channels extended northward on the east and west of the island, and united near where Ludlow Grove now is, and thence together held their way northward to Hamilton; there they turned to the west and south, and reached the Ohio River Valley as it is now, somewhere near Lawrenceburg, Indiana, by following the course now used by the Big Miami. In those days a barrier of land stretched from Price Hill across to the Kentucky side. It is supposed that during the glacial period the end of an immense glacier extended south as far as the Ohio River, and at Cincinnati so completely blocked the channel as to compel the river to seek another course. But at the close of the ice age, and when the glacier had melted, the river attempted to return to its former channels. Finding, however, its old bed filled with sand and gravel, the *débris* of the retired ice-field, and finding, perhaps, that the former impassable barrier had lost some of its height, it beat against it, gradually wore it away, and cut for itself a new channel from the mouth of Mill Creek to Lawrenceburg.

Natural Gas at Pittsburg.—From a lecture delivered at the Franklin Institute, December 18, 1886, by Mr. Charles A. Ashburner, Geologist in charge of the State Geological Survey, it appears that there are now six natural gas companies in Pittsburg, managing 107 wells, and supplying the gas through more than 500 miles of pipe, of which 232 miles are in the city proper. The total area of pipe leading into Pittsburg is given as 1,346,608 square inches, and the total capacity of the mines is estimated at more than 250,000,000 cubic feet of gas per day. One company supplies more than 400 manufactories and 7,000 dwellings with all the fuel consumed in them. The composition of the gas varies greatly, but it may be generally described as a mixture of hydrogen, nitrogen, and marsh gas, with occasionally higher carbon compounds. A thousand cubic feet of gas is calculated to equal in heating capacity fifty-five pounds of coal. The use of gas for domestic purposes has been facilitated by the inventions of Mr. Westinghouse, among which are a device for preventing leaks and a pressure-regulator. The gas is furnished to the consumer on a yearly contract with a company for supply at certain rates and costs, to heat and light a house containing twelve rooms for from $70 to $90 a year. With it, every room may be kept at a temperature not varying two degrees, regardless of the condition of the outside temperature, or of pressure on the mains. While the lecturer admitted that the source of natural gas is capable of exhaustion, he did not think there was any imminent danger of such a calamity.

Origin of the "Second Growth" in Woods.—The origin of the second growth that springs up after a forest has been cleared away, which is usually different in kind from the previous growth, has given rise to one of the problems that have never been solved. Perhaps the most frequently suggested explanation is that it springs up from seeds that have lain dormant in the ground for centuries; but aside from its being hard to conceive of seeds preserving their vitality for so long a time under the conditions to which they must be exposed, this supposition does not account for the

origin of the seeds. Dr. Clevenger, of Chicago, thinks that the soil has been substantially exhausted of the constituents favorable to the growth of the original timber, and has become more suitable for the support of other or complementary sorts; but as against this, evidence of the supposed exhaustion seldom exists, and the origin of the seeds is still unaccounted for. Mr. John T. Campbell, of Rockville, Indiana, a practical woodsman, supposes that while most forest-seeds are not ready to grow in the leaf-fall of the parent tree, other seeds and nuts are transported for long distances and in great numbers by crows, woodpeckers, squirrels, etc., and that these are the seeds from which the new growth arises. This theory must depend largely upon whether nuts are actually transported in such numbers as it requires, by the agencies mentioned. Mr. Campbell adduces an incident that occurred under his own observations, in which, if not the identical thing, something very like it was done.

Work and Play in Instruction.—School Superintendent B. A. Hinsdale, of Cleveland, Ohio, remarks, upon a precept laid down by President Eliot in one of his addresses that "a subject is good for a child precisely in proportion to his liking for it, or, in other words, to his taste and capacity for it," that a capital distinction should be made between work and play. The object of education is to learn to do work. This fact should not be lost sight of, even though the road to the end be made to lead, at times, a little way through play. "The child has a spontaneous nature that should be harnessed to studies and to the whole work of life. Automatic attention is that state of the mind in which its energy is given to a thing from some native affinity or attraction; volitional attention, that state in which its energy is given by act of choice. The development of volitional attention is one of the highest results of discipline. Now, in training the child the spontaneous attention must be rallied to the support of the volitional, which is weak or does not at first exist at all, but as time goes on the volitional attention should grow and become more and more independent of the spontaneous. Humor has been likened to the lever, by means of which we raise great weights with a small force. Love and enthusiasm are also powerful motives. There is a large suggestion for the teacher in the fact that a little boy who has complained bitterly of the wearisomeness of walking will, when put astride of his grandfather's cane, and told that it is a horse, scamper away all forgetful of his previous complaints. But somewhat of life consists of walking when one is weary, and no boy is fitted for life who can not walk. The child should indeed be led to the hard by the way of the easy, but the man has no real training or character who can not, on due occasion, collect his powers to do a multitude of things that he considers hard and disagreeable. The spontaneous powers keep us alive in infancy, and death comes when they wholly fail us, but the highest end of education is the fullest development of the judgment, the moral sense, and the will. Hitch the spontaneous forces to your wagon by all means, but, if you have no other horses, you should not be surprised to find that you drive a balky team. . . . It is not true that nothing is good for training that is not hard, but it is true that no training is complete that does not involve much severe and vigorous labor. It is not true that mental exercise is useful only when it is repulsive and distasteful, needing a dead-lift of the will, but it is true that a good many of such 'lifts' have to be made, and the child must be got ready for the lifting. . . . In a word, my whole contention is that the child must be brought, progressively, of course, to measure his full powers with the labors and difficulties of life."

How the Structure of Rocks is determined.—Mr. George F. Becker, in a paper pertinent to some differences of opinion between himself and Messrs. Hague and Iddings, of the United States Geological Survey, concerning the rocks of the Washoe district, remarks that, given the chemical constitution of an eruptive magma, the mineralogical results are dependent solely on the physical conditions to which it is subjected. It is not a question, therefore, whether, if similar magmas are subjected at different times to similar temperatures and pressures, similar mineralogical results

will ensue, but whether at different geological eras the physical conditions attending the cooling of eruptive masses have been substantially identical. That this has sometimes been the case will scarcely be denied. The problem with which geologists have to deal, however, is not precisely that just stated, for, since the earlier formations have been deeply eroded, while the degradation of comparatively recent rocks is, as a rule, correspondingly small, upper portions of more recent eruptions have to be compared with lower portions of more ancient eruptions. The lithological problem is, therefore, greatly complicated. The main purpose of lithology being, as the author believes, to trace the physical conditions through which a mass of readily ascertainable chemical composition has passed, in the present state of ignorance concerning the effects of temperatures and pressures, the most rational method is to study and record every peculiarity of every occurrence and every perceptible difference between rocks. . . . Rocks can, of course, never be classified with the sharpness of minerals. Rocks are essentially mixtures, and therefore pass into one another insensibly. The wonder is, that rocks not only conform in some degree to a system, but that certain lithological types exhibit such an extraordinary persistence, being met with at the most remote quarters in typical development. While the very nature of things thus excludes a rigid classification of rocks, observation clearly indicates the possibility of reducing them to a natural system.

Unfounded Fears.—Something is occasionally said about the expediency of avoiding heavy work in very warm weather. The "Lancet" evidently thinks there has been too much talk of the kind, and expresses views of its own on the matter. It says: "After it has been proved to demonstration that nothing whatever should be done, in schools, particularly, during hot weather, we shall be quite prepared to make common cause with the school-children in the endeavor to demonstrate that it is undesirable to do anything in cold weather either. In short, let us give up eating, drinking, working, playing, sleeping, and living, in the last issue, lest some harm should befall. It is rank nonsense to write and speak, as too many who ought to be better informed are writing and speaking just now, as though every act of existence were beset with peril. It would be better for all of us and the world at large if less ingenuity were spent on the invention of scares, and in the pitiful task of working on the fears of the public."

Caries of the Teeth.—Caries of the teeth has been but little investigated scientifically, according to Professor Busch, of Berlin, because in studying it the external hurtful processes have been alone considered, whereas the second important factor, the resisting power of the teeth, has been overlooked. It appears to be peculiar to man, having been observed in no animal; but not to be characteristic of civilized man alone, for it has been observed in large collections of skulls, including those of prehistoric time. Some races are more disposed to it than others. Certain families are particularly predisposed to it. General habit of body has a pronounced influence upon its development, as well as certain peculiarities and crises of physical condition and disease. Disposition to caries shows itself even in the developing tooth in the composition of its enamel, which is undulating, whereas teeth with quite smooth enamel have much greater power of resistance. The enamel appears to be the only tissue in the body which is subject to no metabolism, and which remains quite unchanged. Every alteration in it which is caused by external influences, and every defect of the enamel, remains during the whole of life, and can never be repaired. Dentine also shows differences in structure as regards its disposition to caries. The dentine tubes either run regularly closely side by side, when the teeth have greater power of resistance; or they branch and surround cellular bodies, or even small air-vesicles, when the teeth fall an easy prey to caries. If dentine has been decalcified at any place by the action of acids, it undergoes putrefaction under the influence of bacteria which do not seem to belong to any particular species. Dentine is sensitive, though nerve-filaments have not as yet been traced into it. Actual toothache does not occur in the course of

carics until it has reached the pulp. The inflammation of the pulp is particularly violent and painful, because the tissue is so richly provided with blood-vessels and nerve-filaments. As the products of inflammation can not escape, they collect and work their way downward, where they produce the most painful inflammation of the roots and the periosteum. The chief object of the rational treatment of caries of the teeth consists in the removal of every particle of carious substance out of the diseased tooth and the protection of the sound dentine that has been exposed against external injurious influences by covering it with a fine substance which is not attacked by acids —gutta-percha, cement, or gold. Although the dentine is not as unchangeable as enamel, but manifests, by becoming firmer or softer, that it is not quite uninfluenced by tissue-changes, yet its caries is not an irritative process that the dentine takes an active part in, but a passive process, and consequently the removal of all diseased portions and the protection of the non-carious part of the tooth suffices to stay the morbid pro cess completely.

Cooking by Steam.—Professor Behrend, of Hohenheim, has described his experiments on the changes produced in the albuminoid matter of various seeds and of potatoes by steaming under high pressure. In a preliminary experiment, the author found that the albuminoids of lupine-seeds underwent considerable decomposition by heating with water under pressure, and that the decomposition was greater as the duration of the heating and the temperature increased. He, therefore, set to work to investigate whether the albumen was dissolved as well as decomposed, and, if so, what the quantitative relations of these changes were in various seeds, and more especially in the raw starch material for the manufacture of alcohol. Yellow lupines, peas, Hungarian maize, dari (*Sorghum tartaricum*), and potatoes in separate lots, nine months dug and just dug, were experimented upon. When the determinations were made, the contents of the flasks, especially when they were very starchy, became viscid and tenacious, like glue, at from 70° to 100° C., and at 130° C. they were almost clear, limpid liquids, with just a few flecks floating about, while, as the heating was continued, the masses became continually darker, the brownness being more or less intense, according as the substance was richer or poorer in nitrogen. It is hence inferred that the brown coloration is the result of the decomposition of nitrogenous substances. In all cases an increase of the soluble nitrogen was observed, especially with lupines and peas. The nitrogenous matter of maize seems less soluble, and not so easily attacked as that of lupines and peas. From the fact that the chief difference observed, after six hours of heating, was in the amounts of the albuminoid dissolved, it was inferred that the solution of albuminoids precedes decomposition, and this was confirmed by subsequent experiment.

Geographical Conditions and Civilization.—Mr. H. J. Mackinder shows, in a paper on "The Scope and Methods of Geography," how the distribution of men, their social and political relations, and the elements of their civilization, are determined by factors of physical geography and of geology back of it. "Each successive chapter postulates what has gone before. The sequence of argument is unbroken. From the position of the obstacles and the course of the winds may be deduced the distribution of rain. From the form and distribution of the wrinkle slopes and from the distribution of the rainfall follows the distribution of the drainage system. The distribution of soils is mainly dependent on the rock-structure, and on a consideration of soil and climate follows the division of the world into natural regions based on vegetation." Certain conditions of climate and soil are needed for the aggregation of dense populations. A certain density of population seems necessary to the development of civilization. Again, comparatively undisturbed strata usually underlie wide plains, and wide plains seem specially favorable to the development of homogeneous races, like the Russians and the Chinese. Yet, again, the distribution of animal, vegetable, and mineral products has done much to determine the local characteristics of civilization. An interesting chapter of geography deals with the reaction of man on nature. Man alters his environ-

ment, and the action of that environment on his posterity is changed in consequence. The relative importance of physical features varies from age to age according to the state of knowledge and of material civilization. The improvement of artificial lighting has rendered possible the existence of a great community at St. Petersburg. The discovery of the Cape route to India and of the New World led to the fall of Venice. The invention of the steam-engine and the electric telegraph has rendered possible the great size of modern states. It must, however, be always borne in mind that the course of history at a given moment, whether in politics, society, or any other sphere of human activity, is the product not only of environment but also of the momentum acquired, in the past; and, for that reason, changes from what is established are not made so rapidly as they would otherwise be made.

Education and Work.—Many persons believe that under the present systems of education, young people are acquiring a distaste for manual labor, and that there is, consequently, danger that the trade and agricultural occupations will be deserted by all but the most inefficient classes of workmen. Much of the experience of English and American society is in favor of this view, and the tendencies in France appear to be in the same direction. As an offset to what may be said in favor of it, the London "Spectator" directs attention to the fact that no dislike of work, even of the roughest character, has appeared among two of the best-educated races. The Scotch, who have been taught for two hundred years, and are now far more thoroughly trained than English national school boys, show no disposition to avoid labor, but are remarkable for persistent and fairly contented industry. The Prussian peasants, "who are as educated as the English will be twenty years hence, work exceedingly hard, and in the country, where their holdings are their own, show none of the resentment at their fate which is manifested in the towns in the form of socialist aspirations. Gardeners, who all over Great Britain are the best instructed of manual laborers, work, more especially when working for themselves, with unusual diligence; and it is matter of constant observation that a laborer who happens by any accident to be a 'bit of a scholar,' can be depended upon when work presses and every man is required. The people of Rome, who can read and write, are far more diligent than the Neapolitans, who can not; and the best workmen in Italy are those who have passed through the army, and so obtained what is practically an education. There seems to be no *a priori* reason why it should be otherwise."

Anomalies in Human Teeth.—Professor Busch has described before the Physiological Society of Berlin various anomalies in human teeth. Among them are anomalies in situation, as in case of the horizontal position of a wisdom-tooth, which, pressing against the third molar, produced inflammation in it; the projection of teeth through the alveolar wall of the maxilla on the anterior or posterior side; exchanges of situation between certain teeth; and irregularities in the number of teeth. Among anomalies in structure are enamel pearls, that is, drops of enamel adhering to the roots, and having no connection with the crown. Anomalies of size are rare; enlargements affect the root more frequently than the crown. Anomalies of the root are sometimes seen in curves, but more frequently as variations in the number of roots. Such anomalies are not frequent; for, out of eleven thousand teeth examined, only about one hundred specimens had been found to present them. Swellings of the teeth are still more rare; and no osseous coalescence of the teeth had ever been observed.

Intelligence of Fish.—Mr. W. August Carter has been observing the habits and methods of fishes, and has thereby been led to assert that "the more we learn about them the more they shine out as an intelligent, crafty, and ingenious race"; and he is convinced that some fish, at any rate, are capable of understanding and being understood by one another. He has seen a shoal of carp approached while resting by an individual from another part of the pond; when, on its arrival, the entire body of fish, following the lead of the solitary carp, migrated to the other side of the

pond whence the visitor came. He has observed fresh-water perch behaving in a similar manner. A further proof of the communicative capabilities of fish is afforded by the manner in which they oftentimes avoid the snares spread for them by men. They not only possess a keen sense of danger, but must have the power of warning one another. Mr. Carter feels confident, from the result of his observations, that coarse fish are able to influence one another, and if this is the case with them, why not with others? "It can not be credited," he says, "that Nature has denied to fish what she has freely bestowed upon all other animals, and therefore I think the further we go into the subject the more we shall realize that the gift of communication has been implanted in the nature of every creature to a greater or less degree."

A Link between Invertebrates and Vertebrates.—Mr. W. Baldwin Spencer, of the University Museum, Oxford, in studying the anatomy and histology of the lizard-like reptile *Hatteria punctata*, found on the pineal body and under the parietal foramen, a rounded mass, provided with a well-marked nerve, which is evidently an eye. A depression of the skin of the head occurs immediately above the parietal foramen, but does not lead down to this structure, which is filled up with a plug of connective tissue that is specially dense around the capsule that envelops the eye. The capsule is also filled up behind with connective tissue, in which a blood-vessel, entering with the nerve, divides and ramifies. "It becomes extremely difficult," says the Rev. W. H. Dallinger, remarking on this discovery, "to conjecture what can be the use of so curiously placed, and at the same time so highly complex, an organ; an eye so buried in its capsule and surrounding tissue, and so covered with the skin of the head as to make it almost inconceivable that it can be affected by even the most intense light; an eye placed, moreover, in a position that suggests no advantage to the present organism." It is also placed in the head of animals well endowed with the normal pair of vertebrate eyes; and on examining it in different lizards it is found in different stages of uselessness, in some being quite isolated from the brain, and in others, as in this *Hatteria*, having a distinct nerve-connection with the hinder part of the pineal body. "The inference, therefore, appears inevitable that it is an atrophied organ; an organ which the evolutional modifications of the original animal possessing this single eye have rendered in the course of ages devoid of function and needless; but at the same time, and by this very means, it is indicative of the ancestry of the organism in which it lingers." Its structure is that of the invertebrate eye, being marked by the peculiar feature in which this eye is different from, or opposite in the arrangement of the parts to, that of the vertebrate eye. Its presence suggests an ancient connection between the vertebrates and the tunicates, and their origin in one common stock; and supplies a new and most direct evidence in favor of the doctrine of the evolution of animal life.

Specimens of Palæolithic Art.—The river Tardoire in La Charente, France, is famous for the caves along its banks, out of which numerous evidences of occupation by prehistoric man have been collected from time to time. Among the objects which M. Eugène Paignon has recently found in one of the caves is a piece of reindeer-horn, perforated, of the form known as staff of command, which is covered with accurate and spirited engravings, and marked by work of such fineness that it can be seen best with a lens. On one of the faces of the staff is a representation of two seals, one of which is seen entire with its four limbs, the hinder limbs being faithfully rendered, and having five digits on each flap. The size of the tail is exaggerated. The body is covered with very evident hairs. The head is delicately executed, and the snout with its mustaches, the mouth, the eye, and the ear-orifice indicate genuine skill. The other seal is not entirely seen. It is larger and shows the marks of long hair on the neck. In front of the larger seal is a fish which may be a salmon or trout, for it is spotted like those fish, and its ventral fins are attached to the abdomen. Three plant-stems are seen near the fish. The opposite side of the horn is nearly covered with two long and slender animals, one

showing its head and the other one the end of its tail. They are probably intended to be seals. On the same side of the horn are three figures of identical form, the meaning of which is not clear, and a figure that may be a hemipterous insect. M. Gaudry has no doubt of the authenticity of this specimen, for he is assured by M. Paignon, who is a lawyer and publicist of repute, and interested in prehistoric studies, that it was found in his presence by his own workmen while digging out the bone-earth from the bottom of the cave.

"Educating up."—Dr. Andrew Wilson suggests that we might with advantage dismiss some of the less useful topics from the curriculum of the common schools, and supplant them by other topics of vital interest to every class of the community. Boys and girls, for instance, are frequently kept working at modern languages, drawing, classics, and other branches, when the teaching of physiology, health, and domestic economy would be of infinitely greater advantage to them in after-life. Some people would think this to be educating down, but Dr. Wilson asks: "Is it certain that by limiting the 'extras'—or what are undoubtedly often useless topics in education in so far as the social life of many of the pupils is concerned—we should be educating down at all? In all likelihood we should rather be practicing the reverse procedure. By imparting a knowledge of the laws of health and economy, we should be enabling the teacher to discharge his duties in a fuller and truer sense than before. . . . Individual culture of such subjects lies at the root of all national advance in health and prosperity. As several writers have shown, the remedy for much of the misery and poverty now existent lies in the better use of the hours spent at school."

An Undulatory Theory of Odors.—M. P. Leclerc has propounded a theory that odor is, like light and sound, a phenomenon of undulation. He cites in support of his view that many substances, like sulphur and copper, do not emit odors until they are rubbed, and it is more reasonable to suppose that the rubbings cause undulations than that under that condition the substances emit matter which can not be detected except as a smell. Again, arsenious acid when thrown upon a burning coal, gives out thick gray fumes and an odor of garlic. In the solid state it has no smell, and no more in the vaporous state if no chemical change takes place in volatilizing it. But, when it is thrown upon the hot coal, a reduction takes place to arsenic, that is volatilized and then reoxidized on coming in contact with the air, and we have a smell accompanying the chemical action the same as in many other cases we have light or heat in connection with it. M. Leclerc, continuing his experiments with a rather imperfect instrument, claims to have produced interference of odors analogous with the interference phenomena of light.

Some British Weeds.—British farms and gardens are troubled by about a hundred and thirty species of weeds, annuals and perennials, with about a dozen biennials. Among the most troublesome and mischievous of them are the bind-weeds and the couch-grass, which will start to grow from so small a piece of root that it is almost impossible to get rid of them. The couch-grass is nearly in place in Italy, where the white, underground stems, which contain a considerable quantity of starch, are gathered and taken to market, to be sold as food for cattle and horses. A variety of this grass, called matt-grass, also finds a place in Holland, where it is put to use for binding together the sandy dunes and flats by the sea. Some weeds have a marvelous power of increase. The history of the ox-eye daisy in this country illustrates this property. Some seeds of the plant found their way in packages to the Island of Colonsay, in the west of Scotland; in the course of a few years the ox-eye had taken possession of the whole island. The common yellow toad-flax was introduced as a garden-flower by a Mr. Ranstead, and is known as the Ranstead weed. Chickweed is said to have been introduced as a bird-seed. The Scotch thistle arrived in a bed-tick filled with its down. The down, having been replaced with feathers, was thrown away, and soon found a congenial home. Some American plants, particularly the water-weed (*Anacharis alsinastrum*), have nat-

uralized themselves in Europe, and are becoming troublesome. All weeds are capable of being made useful as manure by plowing them in while they are green and before they have seeded.

NOTES.

A NEW feature in the summer courses in chemistry at the Harvard University Laboratory this year, will be a course comprising the work required in preparing for the admission examination in chemistry for the freshman class at Harvard College. It is based on Professor Cooke's recent pamphlet, and is offered to students and to teachers in preparatory schools. The usual courses in general chemistry, qualitative and quantitative analysis, and organic chemistry, will be given, and possibly a course in mineralogy. The courses will be under the direction of Arthur M. Comey, Ph. D., and will open July 11th and close August 20th. A course in practical botany, designed specially for teachers, will be given at the Harvard Botanical Garden, from July 6th to August 6th, under the direction of Professor Goodale. Further particulars will be furnished by the assistant in botany, Mr. J. E. Humphrey, No. 6 Divinity Hall, Cambridge, Massachusetts. All these courses are open to women. The total number of students in the chemical courses last summer was forty-three, and in the botanical course thirty-three.

M. CHEVREUL, one hundred years and eight months old, presented to the French Academy of Sciences, on the 9th of May, a memoir by M. Arnaud, recording the constant presence of the red-coloring alkaloid, carotine, in the leaves of all plants. The illustrious "dean of the students," whom M. Stanislas Meunier does not recollect to have ever seen "more alert, more enthusiastic in the exposition of natural truths, or more youthful in action," insisted on the precise character of the paper, and emphasized the association of chlorophyl with this substance of complementary color to its own. At the end he promised to revert to the subject and to discuss some other points in a future memoir.

IT seems probable that for any further increase of speed in steam-vessels we must rely upon the engineer rather than upon the naval architect. The lines upon which our fastest ships are built can hardly be improved upon; but in the matter of power there is still an enormous waste. It is estimated that only one half of the total power exerted by the engines is effective in propelling the vessel. In addition to this, a very considerable portion of the heat-energy of the fuel escapes through the funnel instead of producing steam. Attention is now given to economizing in these matters as well as in the space allotted to engines, boilers, and fuel. The separation of freight from passenger traffic, after the system pursued on railroads, is destined to be an important factor in facilitating the construction of passenger-vessels of increased speed.

ACCORDING to Dr. Charles H. Burnett, of Philadelphia, the use of properly constructed ear-trumpets improves the hearing permanently as well as aids it for the time. The cause of deafness being usually anchylosis produced by a catarrhal thickening of the mucous membrane of the auditory parts, passive motion overcomes the immobility that has been induced in them. The form of passive motion which acts most naturally here is that of sound. This form of passive motion, augmented as it is by means of the ear-trumpet, acting frequently and systematically upon the ear, prevents further anchylosis, and the fatty degeneration of the auditory nerve that comes from desuetude. This, of course, tends to a permanent improvement of the hearing, and in some cases patients come to hear without the trumpet.

PREPARATIONS for the New York meeting of the American Association, to begin August 10th, are being carried vigorously forward. The President of the Local Committee of Arrangements is Dr. F. A. P. Barnard, the local treasurer is General Thomas L. James, and the local secretary is Professor H. L. Fairchild, Columbia College, New York. The Vice-Presidents are Chauncey M. Depew, Mayor Abram S. Hewitt, George William Curtis, Vice-Chancellor Henry M. MacCracken, Professor J. S. Newberry, Morris K. Jesup, and Judge Charles P. Daly. The whole committee numbers nearly five hundred. There is a large Ladies' Committee, of which Mrs. A. S. Hewitt is chairman, Mrs. Nicholas Fish, first member; Miss Winifred Edgerton, secretary; and Mrs. Sylvanus Reed, treasurer. The sessions of the Association will be held at Columbia College, where the rooms are ample for the several sections. A number of receptions and excursions have been spoken of already, but nothing definite can be said about these until the sub-committees report. The outlook is very promising, and the hope is indulged that the New York meeting will be the most successful in the history of the Association.

M. DE QUATREFAGES and M. H. Chevalier have given their adhesion to the theory, which is taught, as to the Aryan race, in its earliest records, that the migrations of peoples in remote antiquity were provoked by the gradual increase of cold in the northern regions.

An International Conference on Celestial Photography held its meetings in Paris from April 16th to the 25th. A large number of countries were represented by eminent astronomers. Of the nearly sixty persons of whom the congress was composed, three were accredited to America. The conference was opened by M. Flourens, who said that a new era was opening for physical astronomy as well as for mathematical astronomy, and that the photographers were writing the first authentic page of the transformations and modifications of cosmic matter, or of the history of the universe. Admiral Mouchez was elected honorary president, and Mr. Struve, of Pulkowa, effective president of the body. The secretaries were M. Tisserand, of the Collége de France, and Mynheer Vande Sande Bakhuyzen, of Leyden.

The latest census of horses gives the whole number in Europe and the two Americas as 54,850,000. Of these the United States has 9,500,000, and Canada 2,624,000.

The one hundredth anniversary of the death of Père Boscovitch, a celebrated physicist of the last century, was celebrated at Ragusa, his native city, on the 13th of February. He was the author of seventy-six volumes, one for each year of his life. He is said to have been the originator of the doctrine of the centers of forces; he wrote a Latin poem on eclipses; he superintended the repairs of St. Peter's Church under Pope Benedict XIV, by which that cathedral was saved from ruin. He was appointed naval optician by King Louis XVI of France, and was intrusted by Napoleon with the measurement of the degree in Lombardy.

Dr. J. Uffelmann asserts, in the "Archiv. für Hygiene," that the proportion of nutritive material in the edible mushrooms has been overestimated, and that those plants are comparatively difficult of digestion.

An international cremation conference is to be held in Milan in September of this year. Among the questions to which its attention will be brought will be those of legislation concerning the transportation of bodies from one country to another; cremation and the preservation of ashes, with especial reference to hygiene and legal medicine; the technical, moral, hygienic, and economical aspects of different systems of cremation; and projects for international legislation with reference to liberty at funerals.

Dr. R. W. Shufeldt has recorded an interesting study of a case of the repair of the bill of a raven after it had been shot off. The ball had carried away the upper bill just forward of the nostrils. The bone had grown again so as to cover the injury, and the horny covering, following suit, had incased the stump formed by the bone. The result of Nature's surgery in the case was, that the injured part was left in such a condition that the danger of subsequent inflammation was avoided, while the form of the resulting stump was as useful a one as could possibly be expected to follow after a wound of such a character.

OBITUARY NOTES.

M. Bernard Studer, formerly professor in the University of Berne, Switzerland, died in that city May 2d, aged ninety-three years. He was called the dean of the geologists of Europe.

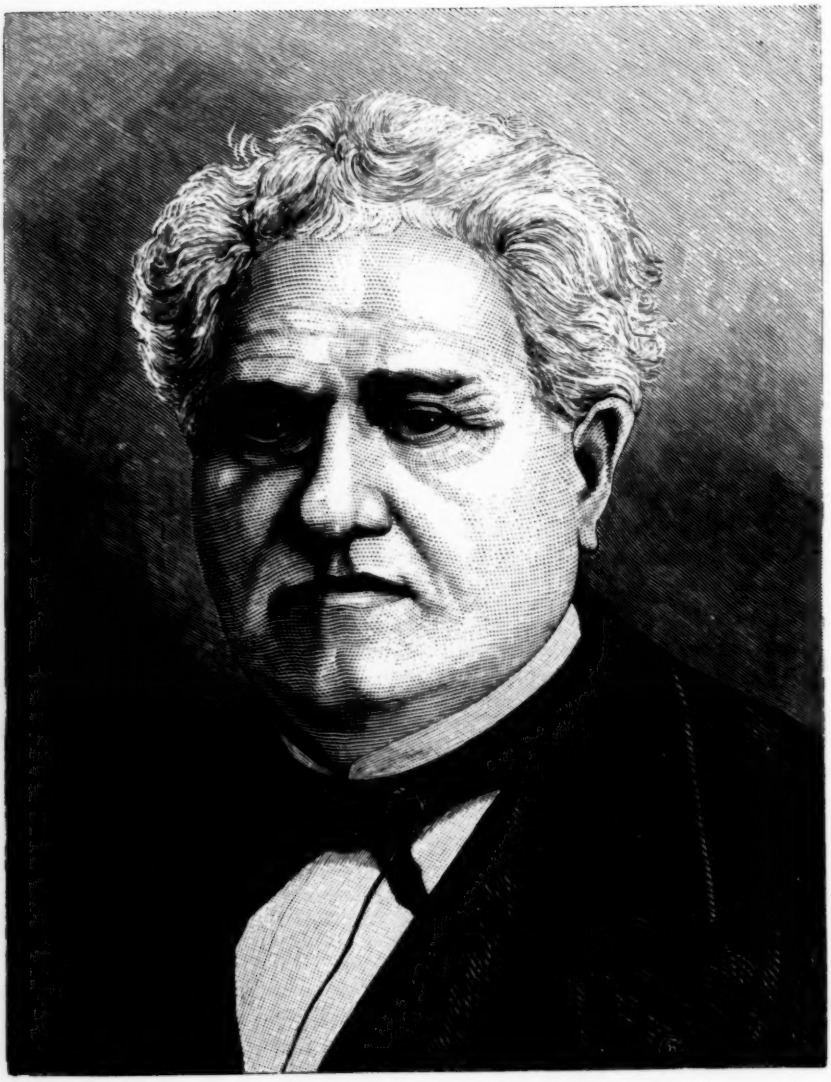
M. Gosselin, President of the French Academy of Sciences, died April 30th. He was born on the eve of the battle of Waterloo, and was consequently in his seventy-second year. He was distinguished as a surgeon.

Dr. E. Félix A. Vulpian, a famous French physician and Dean of the Faculty of the Academy of Medicine, died May 18th, in the sixty-first year of his age. He became Professor of Pathological Anatomy in 1867, and was the author of important works on the nervous system and its diseases.

Mr. William Cameron, explorer and geologist to the Government of the Straits Settlements (Malacca), died in the latter part of last year, aged fifty-three years. He had been engaged lately in mapping and exploring the unknown parts of the native states. He was well known throughout those states, especially among the Malays and Sakies, of whose language and customs he had an accurate knowledge, and over whom he had great influence.

On the 13th of April occurred the death of Herr J. B. Obernetter, who was well known for his researches in photographic chemistry, at the age of forty-seven years; and on the 14th was announced the death of Dr. Nathaniel Lieberkühn, Professor of Anatomy at the University of Marburg, in the sixty-sixth year of his age.

M. J. B. J. D. Boussingault, chemist and investigator in scientific agriculture, died in Paris, May 12th, aged eighty-five years. He spent several years of the earlier part of his adult life in scientific investigations in South America. Having returned to France, he was appointed Professor of Chemistry at Lyons, and afterward to the chair of Agriculture at the Conservatoire des Arts et Métiers. He was the author of a book and of numerous papers on agricultural chemistry and physiology.



PAUL GERVAIS.